EARTH

AS

A TOPICAL APPLICATION

IN

SURGERY.

BEING

A FULL EXPOSITION OF ITS USE IN ALL THE CASES REQUIRING TOPICAL APPLICATIONS ADMITTED IN THE MEN'S AND WOMEN'S SURGICAL WARDS OF THE PENNSYLVANIA HOSPITAL DURING A PERIOD OF SIX MONTHS IN 1869.

BY

ADDINELL HEWSON, M.D.,

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With Four Photo-Relief Illustrations.

"*What relates to Truth is greater than what relates to Opinion.*"—BACON.

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TO

SAMUEL D. GROSS, M.D., LL.D.,

Professor of Surgery in the Jefferson Medical College, Philadelphia,

THIS VOLUME,

THE RESULT OF INVESTIGATIONS,

HONORED AND ENCOURAGED BY MANY FRIENDLY EXPRESSIONS OF HIS INTEREST AND APPROVAL,

IS RESPECTFULLY AND GRATEFULLY

Dedicated

BY

THE AUTHOR.

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PREFACE.

The following pages contain the results of clinical work done nearly three years ago, which have been delayed in their publication until now for the double purpose of weighing them by subsequent experience, and of interpreting their meaning by a careful study of the various subjects which they involve.

In order to accomplish the latter purpose I have not hesitated to quote extensively from various authorities, at the risk of reproducing much that is well known, and even perhaps of taxing the reader's patience.

By discussing these subjects from a strictly chemical point of view, and in reference chiefly to the part taken by oxygen in producing them, I would have no other inference drawn than that as this furnishes, in my opinion, a satisfactory explanation of the phenomena, the discussion of the subjects from other standpoints is unnecessary here. The disposition of the most recent observers to give a more prominent place, than was formerly accorded, to the chemical relations of the elements involved in nature's varied processes, has not only rendered my task in this respect easier than it would formerly have been, but brightens the prospect of the dissipation of those objections to the use of earth in surgery which are founded on old ideas.

In this connection I cannot refrain from making some comment on the fact, discovered as I am going to press with this volume, that the article on the *Process* of Inflammation in volume first of the original edition of Holmes's System of Surgery, written by Mr. J. Simon, and from which I have freely quoted, has been suppressed in the second edition of that volume, for the reason that "all previous doctrines on the subject are just

now in the very crisis of a reconsideration," and the intention is there made known of devoting a separate paper to the subject before the close of the work, so as to secure the latest views concerning it. The paper so promised has just appeared, and is from the pen of Dr. Burdon-Sanderson, well known for his zealous pursuit of such studies. It gives us a most admirable résumé of the subject, but does not make it necessary for me to abandon what I have quoted from Mr. Simon's article, for the substance of what I have quoted is retained by Dr. Sanderson, and, as I before intimated, my purpose has been not to discuss the subject *in extenso*, but only so far as it might facilitate the interpretation of the results of my cases.

Since it became very generally known that I was engaged in these investigations, a large amount of matter relating to the past history and the recent uses of earth for surgical purposes has been sent me from various parts of the world, from points as remote even as South America and Australia. This was the result chiefly of the publicity given to my earliest researches at the hospital, by an account in the "New York Post" of February 24th, 1869, in which Colonel George E. Waring published, without my knowledge of his intention, an interesting and faithful description of what he had seen in my wards a few days previous. Much of the information which I have thus received would, I am confident, be both interesting and instructive to the reader, and my intention to incorporate it in the first publication I should make on the subject has been frustrated only by the bulk of my own material. I have, indeed, from this very circumstance, been compelled to confine myself on the present occasion to an exposition of my first six months' experience only. I have not done this, however, without some satisfaction, for my inferences of those times have not only been thoroughly confirmed by more recent experiences, but there were numerous and constant witnesses of the cases, and by giving the details of *all* of them, I avoid the suspicion of suppressing anything which could have then led me to other conclusions, and they furnish the fairest means of judging of the correctness of the views which I now hold. I hope, therefore, that all who have favored me with communications on the subject will accept my thanks for the same, and be assured that

they have been a means of stimulating my investigations. Furthermore, I would take this opportunity to urge them, and all who are in the possession of facts and experience as to such uses of earth, to publish some account of them at as early a date as possible, and so freely disseminate their knowledge concerning the matter.

The illustrations, four in number, which I have introduced, for the purpose of giving a demonstration as strong as possible of my successes, have been made by the American Photo-Relief Printing Company, and are from photographs reproduced by a method that would seem to leave nothing to be desired as to permanency, as well as faithfulness and accuracy of representation. This method consists in taking from a negative a positive on a sheet of gelatine, impregnated with bichromate of potash, by exposing such a sheet to the sunlight under the negative, as in the ordinary way of photograph printing. The effect of the bichromate is, that wherever the light acts, the gelatine is rendered more or less insoluble in water, whilst, wherever the light does not act, it remains perfectly soluble; so that after a proper amount of such exposure, and then placing it in hot water, those parts of the sheet which have been acted on remain more or less of the original thickness, whilst those which have not been are washed away. In this manner the sheet is converted into a print of raised and sunken parts. This is next placed on a steel plate, and upon it a plate of type metal is laid, and the whole is submitted to heavy pressure in a hydraulic press. Thus a type-metal plate is produced with raised and sunken parts, corresponding to the sunken and raised parts of the gelatine print, and all the lights and shadows of the object are faithfully reproduced, and with as much definition as they were represented in the original negative; the lights by reliefs and the shadows by hollows. From this plate pictures are finally made in a printing press, in pigment, without the agency of light, and are as unchangeable as the printed text of a book. This invention, which has been pronounced by high authority (the editor of the "Photographic Art Journal" of London), as the greatest of all advances made in photography since the introduction of the collodion process; and by another authority (Thomas Sut-

ton, B.A., Cantab.), as one of the most remarkable achievements of modern chemistry and mechanics, is, like most such inventions, the work of many minds and hands, but the result of the combinative genius of one individual, Mr. Walter Woodbury, of England. The truthfulness and accuracy with which this process reproduces the representations of photography can be well judged of by the pictures in this volume, for in some of them there are artistic defects evidently from the negatives, and which were unavoidable. This is particularly noticeable in that of Case XI, the face of which is dark; the negative in that instance, however, was taken in the ward of the hospital, where the light could not be made suitable for the purpose; whereas the picture of Case XLVIII is from a negative taken under the most favorable circumstances, and will bear the closest scrutiny. All four of the illustrations, however, exhibit most perfectly the effects of the dressings for which they are introduced, and hence need no apology from me.

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INTRODUCTION.

ABOUT the beginning of the year 1869 my attention was called to a small pamphlet on "Earth Closets; How to make Them," &c., by George E. Waring, Jr., and having been zealously engaged, like many others, in the search of some more efficient disinfecting dressing than had yet been made known for offensive wounds and ulcers, my thoughts were naturally directed, on the perusal of this pamphlet, to the possibility that the disinfecting power of earth therein set forth might be turned to advantage in surgery. I accordingly resolved to give it a thorough trial in the first fitting cases which might come under my care during my next term of service in the Pennsylvania Hospital, which was to begin on the 1st of February. It so happened that on the very day I took charge of the wards, my predecessor had performed a resection of the tibia in a case of compound comminuted fracture of both bones of the leg, from injury received some nineteen days previous. To the earlier part only of the history of this case, which will be found in detail elsewhere, I will now refer with some minuteness, in order to show how eminently fitted it was, not only to test this property of earth, but also to exhibit others, the existence of which had not been anticipated by me. The patient was a hearty, temperate German, 33 years old, who had been run over, on the 11th day of January, by a cart loaded with a ton of coals. A wheel of the cart passing over the right leg had produced the fracture as indicated above, at about the junction of the middle and lower thirds of the limb. The opening in the integuments was on the shin surface, and had evidently been made by the upper end of the tibia being thrust through the integuments, and was sufficiently large, I was informed by the resident, to admit of two fingers being passed into it.

Attempts at reduction of the displacement, made by the resident (Dr. Ritz), immediately after the patient's admission, were futile, and the limb by the next day had become very much swollen, and it was not then deemed advisable to make further attempts at reduction. On the second day the original wound was enlarged, but no reduction was accomplished on account of muscular spasm. On the fourth day the distension was such that a free incision (of nearly two inches in length) was made along the tibia some distance above the seat of fracture, and from this there was a free escape of pus and broken-down blood. But even after this it was found impossible to reduce the deformity, and it was finally determined, by my colleague, to resort to resection for the purpose. This he did on the 30th of January, nineteen days after the injury was received. After the operation the limb was put into a fracture-box and covered with bran. The next morning the patient reported that he had suffered a great deal through the night from pains and cramps, and on uncovering the limb the deformity was found to be as marked as ever, while the muscular spasm was such that it was not possible to reduce it. On the next day I tried the effect of flexion at the knee, and finding that it favored somewhat the reduction, I suspended the limb in the box of bran some six inches from the bed, with the heel pendant. After this change he expressed himself as more comfortable, but he was still in great pain, and the limb became more swollen, and looked, in the course of a couple of days, as though it was going to be the seat of phlegmonous erysipelas. By the 6th, a depot of pus had formed on the outside of the leg a few inches above the plane of the fracture, to which I gave a free vent by a deep incision. The discharge from the original opening (which had been enlarged in the operation of resection), and from that made on the 23d of January over the shin, was now so profuse as to run through the box of bran, and necessitated the removal of the dressings twice in twenty-four hours; and even with this care, it was not possible to keep the ward free from the stench to which the case gave rise. The spasm of the muscles on the calf of the leg being now as great as ever, I resorted to the division of the tendo Achillis, using the ether spray to prevent any pain from

the operation. These measures, with the free internal use of stimulants, tr. ferri chl., and anodynes, did not improve the patient's condition. The openings all evinced a disposition to slough; the original one measured on the 9th, three inches in diameter, with its margins decidedly gangrenous, and sloughs of cellular tissue began to protrude through the opening made by me on the outer side of the limb. The case was now offensive in the extreme, and I felt it was one to test, in the severest manner possible, the power of the earth as a disinfectant. In anticipation of using it in this case I had had some earth taken from a heap in the hospital lot left there from the excavation for our new lecture-room, and had it well-dried and finely sifted. This earth was rich in yellow clay. Putting a wad of wet paper in the seat of fracture, lest the earth might do mischief there, I covered first this opening and then the other with the earth, and to my great delight I found the wounds most thoroughly disinfected. I then prepared a Scultetus bandage of waxed white tissue-paper, sufficient to envelop the limb from the ankle to the knee, and on the portion of this bandage with which the back of the leg was to come in contact, I placed a layer of the earth, half an inch deep, and letting the limb rest quietly on this, I then, as each strip of the paper was drawn up and folded over into its place, had some earth put on the part so as to make a correspondingly thick layer all around the limb. A roller bandage was then put on from the toe to the knee, and the limb was suspended in a flexed posture by an anterior splint of wire (Prof. N. R. Smith's). The patient expressed himself as very much gratified at the change, and the disinfection was appreciated by every one in the ward. Expecting the pus would run through this dressing, I had a piece of oil-cloth spread under the limb, with some earth sprinkled on it, and directed that the dressing should not be disturbed until the next morning, that I might see the effect for myself. On going into the ward then (the morning of the 10th), there could be perceived the old smell from this case, but it was not as bad as it had been, and on inquiry of the patients and others, I learnt that it had not become perceptible until towards midnight; there was none of it when my resident paid his usual evening visit, and on re-

moving the bed-clothes, I found that about a tablespoonful of pus had dripped through the dressings on to the bed where we had put the earth to receive it. On covering this collection with earth there was no longer any odor perceptible about the bed, and after rubbing some of the pasty mass so formed with a sufficient quantity of the dry powder to make it of the consistency of recently upturned earth, the closest examination could not detect any other odor than that common to damp earth. This demonstration was, under the circumstances, far more satisfactory than I had any reason to expect, and I hastened to see what effect the earth had had on the sloughing surfaces. The patient said he was more comfortable than he had been since he was first admitted, and on uncovering the limb, I found the clay everywhere wet throughout, but there was less evidence of pus than I had expected. The earth looked as though it had been wet with water, except where it was directly in contact with the suppurating surfaces; there it had a thick film of pus on it. On removing the wad of paper, and pressing so as to make the pus escape out of the other openings, we got the old fetid smell formerly perceptible even in the ward on entering it from this case, at any time in the twenty-four hours. Every one was struck with the very apparent diminution in the quantity of pus, for the length of time which this dressing was allowed to remain was double that which we had ventured to leave the bran on. It really appeared as though the quantity of pus had diminished more than one-half. Thinking that the waxed paper had tended to make the clay wet by retaining the perspiration of the skin, I used, in the next dressing, plain unglazed paper out of which to make the Scultetus covering. The record, at the end of the second period of twenty-four hours was, that "the ulcerated surfaces are assuming a healthy appearance," and having had the dressing repeated twice in the day, there was no fetor from the case at any time when examined. And on the next day "the fetor from the limb, when uncovered, was very much less" than it had been for some time before. The ulcerated surfaces were then all of them free of slough, and by the 14th (the fifth day of using the earth), the discharge had so much lessened that it was no longer necessary to renew the dressing

oftener than once a day. At the end of the twelfth day (morning of February 21st) it was noted that the first opening made over the shin for the escape of pus and grumous blood, and which had subsequently formed an oval ulcer, full two inches long, "had almost completely cicatrized."

On testing the discharges, it was found that that which was in contact with the earth was perfectly neutral, whilst that from the deep tissues and the seat of fracture was markedly alkaline.

I had thus, at the very outset of my trials of earth as a surgical dressing, demonstrated to my own satisfaction not only its efficacy as a deodorizer, but its power to effect in a beneficial manner the healing of inflamed ulcerated surfaces. This induced me to test it, in a case of painful varicose ulcers, on a patient who had been some time in bed under other treatment. When I dressed his leg with the earth, for the first time, in a manner similar to that used in the case of compound fracture, he expressed himself as greatly relieved of the pain which he had up to that time been suffering, and this relief continuing with the continued use of the earth, made it appear to be due to the dressing. It was manifest as soon as the earth was used, and such relief not having been experienced before its use, and there being no other assignable cause for it, made such a conclusion quite plausible, especially as it accorded with what had been noticed, although not in so marked a manner, in the first case.

These results determined me not only to continue the earth as a deodorizer, but to try it as a primary dressing after an operation, and the effects of its use, in the first case (Case XI) in which I so tried it, were of a most decided character. The case was one of the removal of the whole mammary gland for scirrhus. The wound inflicted involved, at a low estimate, over forty square inches of surface. The operation was performed under the effects of ether, and the patient was not dressed until after she had fully reacted, and was suffering from the burning pain so characteristic of freshly incised wounds. This pain was not only relieved by covering the wound, when coaptated, with the earth, but the patient also made a most rapid recovery. By the seventh day she was up and about the ward, and it was then

noted that "union had taken place between the edges of the wound throughout, save at one point, from which there was then discharging an ichorish pus." From this point I removed on the next day (the eighth) a shred of oakum, some of which we had used instead of sponge in cleaning out the wound of coagula, at the first dressing. I drew this out of the opening myself, and was confident it had been acting as a foreign body, and had prevented the healing at that place. The subsequent history of the case, which will be found detailed with the others, shows that this idea was the correct one. The condition of the wound, on the tenth day after the operation, can be judged of by the photograph, which I had then taken. From the effects thus early observed in these cases, I felt justified, not only in carrying on further experiments with the earth as a dressing, but of doing so in the most thorough manner possible. And that such experiments should be as impartial and rigid as could be desired, I determined, as I had then learnt that the earth could not do any harm, to exclude every other kind of dressing and topical application from my wards, not only the washes and ointments in common use, but even poultices and caustics, until we could form some definite ideas of the power of the earth as a topical application.

On discussing my purpose with our steward, Mr. W. G. Malin, he exhumed a letter he had received some ten years previous, in which it was there suggested to use *mud* instead of flaxseed, or other mucilaginous substances, for poultices. This letter, which I give below, will be found to contain the germs at least of the very idea I was attempting to develop:

LIMA P. O., DELAWARE COUNTY, PENNA.,
July 29th, 1857.

WM. G. MALIN:

In a few words I wish to bring to the notice of those who have ample opportunity of examining into its value, a suggestion which may or may not be of some importance. I mean the use of the earth to ill-conditioned sores.

Plants introduce their roots into the soil, and it makes the best application to wounds on the more elevated parts of trees. Some animals burrow and pass most of their time in the earth, others roll themselves in mud, and others again seek the earth as a suitable place for repose; indeed it seems well suited to organized nature. The farmer, as he

trudges along his furrow covered with dust, never doubts its healthfulness, if he does not permit it to remain on his skin too long. The Arab of the desert, performing his religious devotions, for the want of water uses sand with which to rub his body, and which no doubt removes the exfoliating skin and exhalations. Offensive smells are sometimes removed from clothing and even articles of food, by being buried in the soil. Fullers use earth in cleaning their cloth, for which soap is not so well suited in many instances. It is an Eastern custom to use scented clay instead of soap at their toilet, which causes the skin to remain smooth, by not affecting the lubricating oil immediately below the surface, which is affected by alkaline soaps. Children that crawl on earth and play in the dust, and occasionally fill their mouths with it, provided their nurses occasionally clean them, are generally healthy. Instead of soap, the earth is sufficient to remove any exhaled matter from the skin, not only by absorption, but by its scouring property in being removed by water. Some animals occasionally lick or eat earth; perhaps by their instinct they find it necessary for their health; indeed, we have heard of savages who eat largely of some varieties of clay, and some families, not over tidy, enjoy good health, while those more scrupulous do not enjoy the best.

We presume nature has provided a material very appropriate, and cheaper for poultices than the slimy pultaceous poultices made of vegetable matter, and inclined to incipient fermentation when applied to certain parts of the body for any length of time. Earth (soil) has some properties we think which fit it for this use; putrefying animal matters emit carbonic gas and ammonia, which damp earth readily absorbs, and prevents reabsorption into the system; the humus poultices may readily be kept moist by the application of water while at the affected point, which cannot be so readily done by slimy poultices: any active ingredient deemed useful could be added to such poultices as to any other kind. The earth we should select would be the primitive earth from woodland, rejecting the undecomposed matter; causing it to be suspended in water for a short time, that the heavy and coarse ingredients might subside, and then have the supernatant water decanted, that the finer may subside for use.

Perhaps the profession might fear being dubbed "mud doctors;" but they are unfit for their profession who object to using the simplest means which nature offers for restoratives; with such means, the healing art is sufficiently abstruse to tax all their genius.

If you think my suggestions worthy of trial in hopeless and extreme cases, I should like to know what success attends it. The study of medicine is one branch I have never attended to, and am consequently unacquainted with its *technology*, which will be discovered.

I am, with respect, &c.,

MINSHALL PAINTER.

I had anticipated that *popular* prejudice would be a serious obstacle in the way of my using such an article in the wards of a hospital, and had therefore resorted to the expedient, in my earliest cases, of keeping the nature of the application a secret from my patients. But I could not continue to do so after I had begun its use to the exclusion of every other application. The duty devolving on the nurses to dry and sift the powder not only made its nature public, but also by increasing their work, excited their hostility to such an innovation. Again, the fact becoming known that I was thus treating surgical affections requiring topical applications, attracted to my wards many members of the profession, some of whom, judging from their conduct, came there with other than the simple laudable desire of seeing what I was doing, and I regret to say were so indiscreet as to give utterance to their disapprobation in the presence of my patients, and so made many of them discontented with the treatment they were receiving, although they were themselves satisfied they were recovering under its use.

One of the most significant of these cases was that of a woman with an epithelial ulcer on the side of her nose. She had been attracted from a town in a neighboring state by what she had heard of our successes with this very dressing, and earnestly solicited admission that it might be tried on her. At first she improved quite rapidly, and was the object of special observation. Then a lachrymal abscess formed, and with it came depression of spirits, and the patient, mooding over the numerous sneers she had heard in reference to the impossibility of her being benefited by the treatment, became so discontented that she sought her discharge and went home. There the original ulcer began again to spread, and after taking advice and trying some ointments without any benefit, she went in a state of despair into her own garden, and digging up some subsoil, dried it, and applied it to the sore as it had been done in the hospital. The improvement which followed this second trial was such that, at the end of three weeks, the patient came all the way to the city (a distance of over ten miles), and reported herself at the hospital as a cure, in her estimation, by dry earth.

In this connection I cannot refrain from the public expres-

sion of my thanks to Dr. Charles Ritz for the thorough manner in which my directions were carried out in the initiation of these experiments. He was the resident in my wards during the first two months of my using the earth, and his earnestness and zeal contributed in a most essential manner to the successes which attended my earliest trials.

Before entering upon the recital of the cases detailed in this volume, which constitute my first six months' experience with the earth as a topical application, I deem it advisable to make some explanations and statements which are essential for a clear comprehension of those details, and which will avoid the necessity of frequent repetitions.

In the first place I would remark that, unless it is otherwise specified, "the earth," "clay," "or clayey earth," spoken of in this volume, was always essentially the same, namely, from deep diggings, well-dried (but not roasted), and sifted through a fine flour-sieve, the yellow subsoil common everywhere in our city and its vicinity, rich in ferruginous clay, and entirely free of all sand, grit, or foreign matter.

Further, the "gauze and collodion" referred to as used in all the cases requiring the support of plasters, is a method of dressing I have employed for a number of years in both hospital and private practice. It is a mode of making the properties of collodion available in surgery, to which we are indebted to the ingenuity of the late Dr. Paul Beck Goddard, of Philadelphia, and consists, as suggested by him, of strips of Donna Maria gauze, which are fixed at either end by collodion, painted across its meshes. The gauze is a strong silken tissue, with meshes large enough to allow the collodion to penetrate and dry on the skin beneath. I have been in the habit of using, as a less expensive but equally efficient article, the tarletan, much employed by old ladies for caps in our plain city. Its mode of application is this: strips are to be cut from such tissue along its woof or lengthwise, and of convenient width, as we cut the ordinary adhesive or resin plaster. The end of one of these strips is to be placed at some distance on one side from the edge of the wound, and there secured by painting collodion over its meshes; when the collodion becomes dry we have the strip so firmly fixed, that it will bear any degree of traction necessary, and far more than the adhesive properties of any form

of plaster will permit. By traction on its free end it is then to be drawn across the wound, the margins of which, if necessary, are to be held in close and accurate juxtaposition by an assistant. Then being satisfied that it gives all the support required, it is to be secured by the collodion at this free end, and at a point similarly remote from the edges of the wound. A series of strips can thus be applied in the closest proximity to each other. Care is taken that no collodion is put in contact with the wound, and there is therefore nothing across its margins but the soft and unirritating fibres of the gauze, the meshes of which allow not only of the free escape of discharges, but of the direct contact of any topical application which we may desire to make. When the collodion has been painted sufficiently far from the wound on both sides to escape contact with the oozings or discharges, and is not disturbed by washing, it will retain a firm hold and give the necessary support to the gauze for five or six days without renewal.

The only difficulty I have ever experienced in the use of this dressing has been due to the occasional vesication which the collodion caused. This property, I am well satisfied, is sometimes due to means employed by the manufacturers to diminish the contractility in the film of the collodion. Thus I have known of Venice turpentine to be used for the purpose, and it is well known that with some skins that article will provoke erythematous inflammation, and even blistering. But a good article of collodion is not open to this objection.

Another point which may be considered sufficiently peculiar to require some explanation is the use of hypodermic injections of sulphate of atropia ($\frac{1}{40}$th of a grain), which were directed always where there was occasion to use any measure to relieve pain or induce sleep. This I first tested some three years previously, and having then become firmly convinced of its efficiency, and of its superiority over opium or any of its preparations in all cases of peripheral irritation, I have since used it almost constantly for such purposes in my surgical practice. And it is no little satisfaction for me to find my conclusions on this point so thoroughly confirmed, as they are by Dr. John Harley, in a recent publication, on "The old Vegetable Neurotics, Hemlock, Opium, Belladonna, and Henbane."

HISTORY OF CASES.

CASE I.

Compound Comminuted Fracture of both Bones of the Leg—Treated with Bran in Fracture-box—Resection of Tibia on the nineteenth day—Bran-dressing continued—Subsequent division of Tendo Achillis—Extensive Sloughing and Burrowing of very Offensive Discharge—Dry Earth used on tenth day after Operation of Resection—Its effect when first put on, Cooling; but when it became saturated, Burning—Removal of Patient from Hospital after the Earth had been used thirty-six days—Sequel: Cure at end of three months' more of Bran-dressings.

Gottlieb M., a German carter, æt. 33 years, of temperate habit, and good general health, was run over by his cart, loaded with a ton of coal, on the 11th day of January. The accident resulted in a compound comminuted fracture of both bones of the right leg, at about the junction of the middle and lower thirds of the limb. The opening in the integuments was on the shin surface of the tibia, and was sufficiently large to admit two fingers to be passed into it. From the appearance of the integuments, the wheel of the cart had evidently gone over the limb on its outside; the opening on the shin surface was as clearly the result of transfixion by the upper end of the tibia. When he was brought to the hospital shortly after the receipt of the injury, the upper fragment of the tibia was overriding the lower, and projecting somewhat through the opening, forming a markedly angular deformity with shortening. Attempts at reduction of the deformity made at that time by Dr. Ritz were futile. The limb was then put in a fracture-box filled with bran, and left till the next day; it was then so much

distended and swollen that it was not deemed advisable to use any force in its reduction. On the second day the original wound was enlarged, but no reduction was accomplished on account of muscular spasm, from which he suffered a great deal. On the fourth day the distension was such that a free incision (of nearly two inches in length) was made along the tibia some inches above the seat of fracture, and from this there was an abundant escape of pus and broken-down blood. Even after this it was found impossible to reduce the deformity, and it was finally determined by Dr. Morton to try resection of the upper fragment of the tibia. This he did on the 30th of January, on the nineteenth day after the injury was received. After the operation the limb was put in the same dressing (bran in a fracture-box) as heretofore. The next morning the patient reported himself as having suffered a great deal through the night from pains and cramps, and on uncovering the limb the deformity was found to be as marked as ever, while the muscular spasm was such that it was not possible to reduce it. On the next day I tried the effect of flexion at the knee, and finding that it favored somewhat the reduction, I suspended the limb in the box of bran some six inches from the bed, with the heel pendent. After this change he was more comfortable, but he was still in a great deal of pain, and the limb became more swollen, and looked as though it was going to be the seat of phlegmonous erysipelas. By Feb. 6th, a depot of pus had formed on the outside of the leg, a few inches above the plane of the fracture; to this I gave a free vent by an incision. The discharge from the original opening, and from that over the shin high up on the leg, was now so profuse as to run through the box of bran, and necessitated the dressings being renewed twice in the day; and even with this care it was not possible to keep the ward free from the stench to which it gave rise. The spasm of the calf of the leg being now as great as ever, I divided the tendo Achillis, using the ether spray to produce local anæsthesia. These measures, with the free use of stimulants, tr. ferri chlor., and anodynes, did not, however, improve the patient's condition. All the openings showed a disposition to slough. The original one measured on the ninth, three inches in diameter, with its margins decidedly gangrenous and spread-

ing, and sloughs of cellular tissue were now protruding through the opening on the outer side. The odor was now offensive in the extreme, and I felt it was one to test in the severest manner possible the power of the earth as a disinfectant. I therefore, after putting a wad of wet unglazed paper over the ends of the bones, covered this and the other openings with some dry, finely sifted, clayey subsoil. This had the effect of immediately destroying all the fetor about the limb, and of relieving very materially the pain. My motive for putting the wad of paper over the ends of the bones was to prevent the earth getting in them and doing mischief. I then prepared a Scultetus bandage of waxed paper, sufficient to envelop the limb from the ankle up to the knee, and on the portion of this bandage with which the back of the leg was to come in contact I placed a layer of this same earth half an inch deep, and letting the limb rest quietly on this, I then, as each strip of the paper was drawn up and about to be folded over into its place, had some earth put on the part, so as to make a correspondingly thick layer all around the limb. A roller bandage was then applied from the toes to the knee, and the limb was suspended in a flexed position by an anterior lint of wire (Prof. N. R. Smith's). The patient expressed himself as very much gratified at the change, and the disinfection was appreciated by every one in the ward. In anticipation of the pus running through the dressing, I had a piece of oil cloth spread under the limb, with some earth sprinkled on it, and directed that the dressing should not be disturbed until the next morning, that I might myself see the effect.

February 10th. On entering the ward this morning, the old smell from this case was promptly recognized, but it was not as bad as it had been, and on inquiry of the patient himself and of others, I learned that it had not become perceptible until toward midnight. There was none of it when my resident paid his usual evening visit, and on removing the bed-clothes it was found that about a tablespoonful of pus had dripped through the dressings on to the earth on the bed. On covering this with earth, there was no longer any odor perceptible, and after rubbing some of the discharge with a sufficient quantity of the dry powder to make it of the consistency of recently upturned

earth, the closest examination could not detect any other odor than that peculiar to damp earth. The patient said he was more comfortable than he had been since admitted, and on uncovering the limb I found the clay everywhere wet throughout, but fewer evidences of the presence of pus than I had expected. The earth looked as though it had been moistened with water only, save where it was directly in contact with the suppurating surfaces, where there was a thick film of pus on it. On removing the wad of paper, and forcing the pus out of the other openings by pressure, we obtained the old fetid smell which had been perceptible about the limb, and was even noted on entering the ward in the morning.

Every one was struck with the very evident diminution in the quantity of pus for the considerable length of time during which this dressing had been applied, which was double that permitted with the bran. It really appeared as though the quantity had been reduced more than one-half. The earth-dressing was then reapplied in the same manner, save that I used unglazed white paper in place of the waxed tissue for the Scultetus, under the impression that the latter had made the limb sweat. I also directed this dressing to be reapplied in the evening.

February 11th. There has been no fetor from the case. It was, however, distinctly perceptible on removing the dressings. "The ulcerated surfaces are assuming a healthy appearance."

February 12th. The fetor of discharge very much less. The abraded surfaces are free from sloughs.

February 14th. The dry earth renewed now only once in twenty-four hours, the discharge having so much diminished.

February 15th. The patient expressed himself this morning as being very much more comfortable than when his limb was in the fracture-box. The wounds are steadily improving in appearance.

February 21st. The ulcer resulting from the incision on the shin above the seat of fracture has almost entirely cicatrized. The patient's general condition has improved.

March 1st. The patient has been steadily improving. The ulcer, above referred to, is completely closed; that at the seat of fracture is cicatrizing rapidly. The patient is annoyed by

a slough on the heel, the result of pressure whilst the fracture-box was used. The dressing is renewed every morning.

On March 8th an incision of about two inches in length to the outer side of the tibia, and some distance above the fracture, was made to give exit to burrowing pus.

March 12th. Another opening was made over the line of the fibula, with free escape of pus.

Some experiments with the clay to-day showed that the discharge which had been in contact with it exhibited a neutral reaction, whilst that freshly obtained from the seat of fracture was alkaline.

March 13th. Two fragments of necrosed bone were removed this morning; they were external laminæ, one from the upper fragment, and the other from the lower of the tibia. The dry earth continues to act as a disinfectant, and forms an excellent dressing.

March 15th. The discharge has increased since the removal of the necrosed bone. The patient appears somewhat depressed in spirits.

March 18th. Although everything has been progressing as favorably as usual for the last three days, the patient has manifested great anxiety about his case, and has determined this morning to go home to be treated. He admitted that parties had suggested that he was not being treated as well as he should be. The ulcer communicating with the fracture measures to-day one and three-quarter inches in diameter, and there is a margin of well-formed cicatricial tissue one and a quarter inches wide all around this ulcer. The ulcer itself is well filled with healthy granulations, so that the ends of the bones can no longer be seen; there is considerable callus around them. The sore on the heel is granulating nicely under the earth-dressing. Patient was discharged on this day at his own request.

Remarks.—The disinfecting power of the earth in this case was of a most positive character. It will also be noted that the sloughing ceased during its use, and that the progress of repair was rapid during the same period.

January 24th, 1870. Through the kindness of my friend, and former resident in the hospital, Dr. T. H. Andrews, I had the

opportunity of examining this patient, G. M., at my office to-day. He then stated he was confined to his bed for three months after he left the hospital, and during the whole of that time was treated with bran in a fracture-box, with the exception of the last two weeks, when the limb required no dressing. He never had any extension or other expedients used to prevent shortening or anterior angularity, and judging by the height of heel which he had on his shoe, the limb was shortened at least two and a half inches, with great bowing forward of the shin. The bones were solid, but united at an angle of over twenty degrees, with retraction of the heel. There was an immense amount of callus around the seat of fracture, evidently encasing some sequestra, as shown by an abscess which was forming at the time of my examination on the outside of the leg. There was dropping of the great toe, evidently the result of the slough produced over the extensor tendon by the bar of the anterior splint. Some five or six pieces of dead bone were removed through the original opening two months after he left the hospital.

CASE II.

Compound Fracture of Metacarpal Bones with Extensive Laceration and Contusion of Soft Parts—Sulphite of Soda used without effect upon the Fetor—Disappearance of Fetor under the use of Dry Earth—Complete Cicatrization without loss of Bone during the use of latter for twenty-two days.

Thomas R., æt. 29, who had always enjoyed good health, received an injury of the hand on the 28th of January, 1869, being caught between the drawheads of two cars which he was trying to couple. The resulting injury was a compound fracture of the metacarpal bones, with extensive laceration and contusion of the integuments. Although the injury was a severe one, it was determined to make an attempt to save the hand for the poor fellow. The parts were therefore adjusted as nicely as possible, and enveloped in a bandage saturated

with a strong solution of sulphite of soda. Notwithstanding this dressing, the discharge by the end of four days became very offensive on account of the sloughs, and continued thus for a week more. The patient complained constantly of pain. I therefore determined to dress the part with dry earth. This determination was carried out on the morning of the 9th of February. It was cool and pleasant; there was no pain afterwards, and directions were given to repeat this dressing in the evening if it should become saturated. This was the case, and after the dressing was reapplied, he expressed himself as very well satisfied with the change. "Thinks that the odor from the discharge was not quite so fetid as in the morning."

February 11th. (Second day of the use of the "dry earth.") The surfaces are looking healthier since application of the earth-dressings. Pain is not so intense. No constitutional treatment or stimulation. Ordinary house diet was directed.

February 12th. The surfaces are becoming covered by healthy granulations.

February 18th. (Ninth day of use of dry earth.) Tumefaction of hand is decidedly less. The ulcers are rapidly closing. The patient remains up all day.

March 1st. There is no discharge. Dry earth has been steadily used.

March 4th. Complete cicatrization. Patient discharged cured.

CASE III.

Varicose Ulcer of Leg, $2\frac{3}{8} \times 1\frac{1}{2}$ inches in size, of over two years' duration, firmly cicatrized, in nineteen days, under Earth Dressings, renewed daily—The effect of Dry Earth in retarding Inflammatory Action, shown in the progress of the case, after an operation, subsequently performed, for the obliteration of the vein.

John G., a laborer, æt. 30, had suffered for over two years from a varicose ulcer on the inner side of the left leg (about four inches above the malleolus). During all this time he had

tried, whilst doing his work every day, various plans of treatment, but without any benefit. The ulcer had remained about the same size, $2\frac{3}{8} \times 1\frac{1}{8}$ inches, with callous edges, and a grayish, shreddy, smooth surface. For this he was admitted to the hospital on the 2d of February, and during his first week there was kept in bed with the part enveloped in paper saturated with a solution of sulphite of soda, 10 gr. to ℥j; over this was applied waxed paper and a roller. The maceration by this wash seemed to have no beneficial effect. The ulcer looked and measured precisely the same as on his admission. Whether the important part of the treatment here prescribed, rest in bed, was attended to I was by no means certain of, owing to the unreliable character of the nurse. I had good grounds for suspecting that it was not, and, moreover, that he was constantly on his feet throughout the subsequent treatment of his case.

On the 9th I applied some dry, finely-sifted earth, taken from the garden of the hospital. This I covered with a piece of waxed paper and a roller. The patient said it was cooling and pleasant. A similar dressing was applied the next day, and at the end of the second period of twenty-four hours the ulcer was evidently looking better, was free of pain, and by actual measurements had diminished one-quarter inch in its long diameter and one-eighth in its short. On that day, February 11th, the earth was put on wet, in the form of a thick paste, and covered as before. The measurements of the 12th (third day of earth-dressings) were $2 \times \frac{3}{4}$, and a bridge of cicatricial tissue was noted as having formed, since the previous dressing, across the centre of the ulcer. Dry earth was then applied, retained by a Scultetus made of paper, over which was put some waxed paper and a spiral, as before.

13th. Ulcer $1\frac{7}{8} \times \frac{3}{4}$; the bridge of tissue across the centre is complete.

14th. Ulcer $1\frac{3}{4} \times \frac{5}{8}$ inches, the bridge increasing in width. Dry earth dressings as on 12th.

By the 25th the ulcer was reduced to a small point, under the daily repetition of the dry earth dressing after washing off that of the day previous, and on the 28th the cicatrization was so perfect that all dressings were discontinued.

Four days later, March 4th, I operated on the varicose vein,

which had been the evident cause of the ulcer. This I did by passing two harelip pins under the vein (the long saphenous) about two inches apart, and the upper one at a point about four inches below the knee. On these pins I compressed the vessel sufficiently firmly to obliterate its calibre by figure of 8, formed of silver wire. The portion of the vein between these two pins I divided completely by a subcutaneous incision. Dry earth was then applied over all, with wax paper and a spiral from the toes up to the knee.

The next day, March 5th, there was very little local irritation to be detected. There were no signs of inflammation about the pins, but the patient's pulse was 88, temperature $101\frac{1}{4}°$.

March 6th. Some redness and considerable heat about the pins. Pulse 94, temperature $101\frac{3}{4}°$. Dry clay reapplied; wax paper covering was omitted, and common unglazed paper used instead. The patient does not suffer any pain. No anodyne has been as yet required.

March 7th. The patient was in some pain last night, and received for its relief one-fortieth grain of sulphate of atropia hypodermically with the desired effect. Pulse this A.M. 100, temperature $100\frac{1}{2}°$. There is still but little irritation in the neighborhood of the pins, indeed, not sufficient to justify their removal. Dry earth is still continued. The range of the pulse and temperature (the former varying from 90 to 100, and the latter from $99\frac{1}{2}°$ to $100\frac{1}{4}°$) for the following five days was the only evidence we had in this case of the existence of any irritation: for where the pins were, there were no more redness, pain, and tumefaction than is constantly seen after the most trifling puncture. On the 14th (tenth day after the operation), the clay was noticed on removal to be slightly moistened, and on pressing on the pins a drop or two of pus exuded. I, therefore, then removed the lower pin, and on the following morning the upper. The earth-dressing was continued. For the next four days no change was to be observed; the same high rate of pulse and exaltation of temperature. No chill or sweat.

On removing the earth, on the 19th, a small ulcer was noticed, as having formed since the last dressing, adjoining the seat of the original one, and there was some burrowing of pus where the veins had been pressed by the pins. On interrogat-

ing the patient closely, he confessed to having been out of bed, and walking about the wards very constantly during the past week. He had experienced considerable pain in these parts during the afternoon before, but had slept well during the night, after the hypodermic of atropia which my assistant gave him at bedtime.

Nothing worth recording here was noted from this time until the 24th, when the patient had an epistaxis and profuse sweat during the night; but as these occurred with other symptoms of the effects of atropia, I attributed them at the time to that cause and not to pyæmia. The sequel proved this to be correct, the ulcers were looking well and healing under the daily dressings. By the 8th of April they were sufficiently firmly cicatrized to allow of the patient going to his work.

CASE IV.

Case of extensive and deep Burns from Coal Oil, fatal at the end of 291 days—Treated during first 102 days by ordinary measures, for the remaining 189 days by Dry Earth Dressings—Positive relief of pain as long as the earth remained dry—Decided improvement in the Ulcers from the application—Death from exhaustive Diarrhœa.

Isabella S., a German, aged twenty-one years, was terribly burned about the chest and arms by the explosion of a coal oil lamp, on the 1st of November, 1868. She was immediately conveyed to the hospital, where her injuries were dressed with carron oil. Subsequently poultices, opiate washes, and zinc ointment, were used. When I took charge of the ward, three months after the accident, she was still under treatment, and was apparently a hopeless case of one of the most horrible of injuries. Her face betokened prolonged suffering, and the fetor from her wounds was such as to be perceived before entering the room where she lay. Nearly the whole surface on the front of the right half of the thorax presented the characteristics of an irritable ulcer, was then discharging freely offen-

sive, ichorous matter. This was also the condition of about one-fourth of the superficies of the right upper extremity, and at the elbow the inner condyle was bare. The rest of the surfaces originally injured, namely, that of the left upper extremity, and front of chest, were well and completely covered by cicatricial tissue, and scars, or marks, the result of the extensive vesication. The patient was very much emaciated, and had been frequently annoyed by diarrhœa. She was taking freely of milk punch, beef essence, iron, and quinine, with opiates. These measures I continued until the 10th of February, when I substituted for the ointment of zinc, which had been in use for some time, the powdered dry earth, covering all the granulating surfaces with it. The contrast of her sufferings at this dressing with those on former occasions was very decided, and in favor of the earth. Its contact was cooling and soothing, and the patient declared she was very much pleased with it. The disinfection was also as marked and perfect. By evening, however, she began to complain of the pain, and there was then an evident fetid odor from the parts. The patient was given four ounces of whisky, in place of the punch, but no other change was made. The earth-dressing was after this renewed once or twice a day, as the fetor made it necessary. At the end of four weeks clay was substituted for the subsoil heretofore used. This was renewed every morning only; its effects were, like those of the earth, cooling and pleasant, until it became saturated with the discharge, then there was considerable "smarting."

By the 6th of March the granulations on the arm were noted to have become perfectly healthy in appearance, and the ulcers on the chest had considerably diminished in size, were reduced to one-half original size. The internal condyle of the right humerus was then evidently necrosed. The patient was still annoyed by diarrhœa. I ordered Hope's camphor mixture. The dry clay dressings were continued, being changed every morning.

March 19th. The patient's general condition is somewhat better. She has been slowly improving; a visible diminution of the size of all the ulcers is noticeable. She is still annoyed with diarrhœa, and has night-sweats. She has been alternating

the eamphor mixture with mist. cret. and iron and quinine, according to her condition, and has had beef essence, whisky, &c. Patieut has frequently stated, in answer to my inquiries, that the clay has eonstantly afforded her relief until it became saturated by the discharge, and that the surfaces then became the seat of a burning pain. The general direction was therefore given to prevent this by more frequent renewals of the dressings. In the pleasant weather of the beginning of May, the patient was well enough to be plaeed iu a wheeled ehair, and taken out into the fresh air nearly every day. But before the close of the month the evidence of the increase of uleeration in the intestinal mucous membrane, to which we had always attributed the eonstant diarrhœa, became alarming. Her emaeiation rapidly increased, and she had an insurmountable disgust for her food. Shortly after this I discovered that the clay had been applied but once in the twenty-four hours, that the patient had been suffering a good deal of burning pain every night, and that the smell from her ulcers had been offensive to the other patients. On making this discovery I insisted upon my directions being faithfully complied with, and the effect was "an absenee of the pain" in the burned surfaces, and a disappearanee of the odor from the ward. This patient eventually died on the 18th of July, exhausted by her diarrhœa.

The post-mortem examination revealed great emaciation, with charaeteristic ulcerations of the intestinal mucous membrane.

This poor creature survived her injury (which, from its character, might well have been originally pronouueed a fatal one) two hundred and ninety-one days. Of this time she was treated during one hundred and two days by the measures ordinarily used iu sueh eases, ineluding lin. liq. ealeis, opiate washes, poultices, &e., aud her experienee was therefore ample enough to enable her to pronounce with some decision as to the value of the earth-dressings, and this she always did to me in their favor. In all instanees when she did suffer whilst they were being used, it was clearly due to their not having been renewed sufficiently often.

CASE V.

An Inflamed Varicose Ulcer, of five weeks' duration, $\frac{5}{8}\times\frac{3}{4}$ of an inch in size, completely Cicatrized in six days' time by Earth-dressings and rest in bed.

Ann Jane C., æt. 55, a weaver, was admitted on the 10th of February, for a varicose ulcer of the right leg, of five weeks' standing. As the ulcer was much inflamed and dirty, a dressing of wet earth was applied immediately after the patient's admission, and she was directed to keep her bed. No pain succeeded the dressing.

On the following morning, the ulcer looked very much better after it was cleaned. Its dimensions were measured, and were found to be $\frac{5}{8}\times\frac{3}{4}$ of an inch. The same dressing was renewed. By the 13th (the third day), all signs of inflammatory action had disappeared, and the ulcer had become reduced to $\frac{1}{2}\times\frac{1}{8}$ of an inch in size. Dry earth was then applied. By the 16th, under the latter dressing, the cicatrization was complete and perfect.

The dressings, in this case, were renewed every morning, after a thorough washing of the limb.

CASE VI.

Scorbutic Ulcer of Leg, of over two years' duration; following Typhoid Fever—No effect from nine days' use of Benzoated Oxide of Zinc—The ulcer thoroughly cleaned off in two days, during the use of Dry Earth—No Constitutional Treatment—No repair until Constitutional Measures to affect the Blood were employed.

A. De H., a single man, æt. 27 years, had an attack of typhoid fever about two years and a half before applying at the hospital, and was thereby incapacitated for work at his calling (that of a stonecutter) for eight months afterwards, in consequence of the prostration which followed it. Soon after getting about he began to suffer with contractions of the flexors

of both legs, and was obliged to take to his bed. Then the integument, first that of the right leg, and three weeks later that of the left, became excessively sensitive. This symptom was attended with some tumefaction and discoloration (livid) of the limbs, especially over the surfaces of the tibiæ. It lasted about six weeks. At the end of that time the right limb had gradually returned to its normal state; but not so with the left. In it suppuration took place, and an ulcer formed just above the malleolus. This ulcer persisted obstinately, and spread steadily from that time up to his applying for admission to the hospital, February 3d, 1869. It then presented all the characteristics of a scorbutic ulcer, with a surface measuring $5\frac{5}{8} \times 4$ inches, and was covered by a strongly adherent and fetid crust. The integuments were livid and scaly, and the periosteum (some distance up the limb) was quite sensitive under those portions.

Benzoated oxide of zinc ointment was ordered to be applied, but no constitutional treatment was directed. Full diet was allowed.

By the 12th (nine days after the treatment by ointment was instituted), there was no appreciable change in the appearance of the part. I then ordered the dry earth to be applied, and that it should be retained by a piece of waxed paper and a bandage. After the lapse of two days this was removed by washing, and the epidermis and the ulcer were found perfectly freed of crust. The dressing produced no pain, but, on the contrary, its use was attended by diminished sensitiveness.

There was no signs of healing in the latter. Dressings continued, but no constitutional treatment ordered until the 9th of March, when it was evident to all who had been watching the case, that the trouble was clearly a constitutional one, requiring essentially eutrophies for its cure. The patient was then ordered 20 ♏ tr. ferri chl., and wet earth was applied. Before the close of a week, after the adoption of this plan of treatment, there was positive evidence of improvement; but the patient having got the notion that he was being made the subject of experiment asked for his discharge, which was promptly given him. He left the hospital on the 15th of March.

CASE VII.

Syphilitic Ulcers on back of Leg, down to the muscle—Failure to heal under Constitutional Treatment—Rest, and Zinc Ointment—Division of Tendo Achillis—Rapid healing without Constitutional Treatment, until patient got up and about—The Development then of three more Ulcers—Their Treatment by Dry Earth--Slow healing until support was afforded by Adhesive Plaster—Result undetermined when patient was discharged for misconduct.

Kate M. was in the women's surgical wards when I took charge of them on the 30th day of January. She had been admitted a month previous for a large excavated ulcer of the right lower limb, situated over the calf of the leg.

History.—She was a single woman, twenty-two years old, and had been living out at service two years and a half before her coming to the Pennsylvania Hospital. She had sore throat, rupia, and other evidences of syphilitic disease. She had been in several hospitals for the ulcer on the leg, and the fact that it had always broken out afresh after she began to use the limb, associated with the original depth and locality of the sore, impressed me with the idea that one great difficulty in the way of a permanent cure, was the gastrocnemius. I therefore divided the tendo Achillis subcutaneously, on the 4th of February. The ulcer then measured $1\frac{3}{4} \times 1\frac{1}{4}$ inches, and the patient had been up to that time under constitutional treatment, with rest in bed and zinc ointment, without any material improvement for more than a week; the ulcer was however in a condition very favorable to healing.

After dividing the tendon, I ordered benzoated oxide of zinc ointment to the ulcer; the patient to keep her bed, but to discontinue the constitutional treatment.

February 5th. The ulcer was found this morning to have diminished fully one-third in its size during the last twenty-four hours.

Under this treatment the original sore was entirely closed by the 15th, without any constitutional remedies, but by that time three new ulcers had developed themselves in the vicinity of the old one and spread with rapidity, the patient having been up and about the ward for some days.

These were dressed for the first time on the 15th with dry

powdered earth; the patient was given cod-liver oil, and allowed to be about the ward. This treatment was continued for over twenty days without any improvement. She never complained about the dressing; always said it felt cool when first applied. She was then compelled to keep her bed, and the benefit of the rest was soon apparent in the healing of two of the three ulcers. She disobeyed orders, and walking about the wards whenever the resident was out of the way, and consequently the remaining ulcer increased its extent from $1\frac{1}{2}$ to $2\frac{1}{4}$ inches in the course of five days. On the 28th of March, the end of the period referred to, I bound the earth *in situ*, by strips of adhesive plaster, and then applied a spiral from the toes to the knee, and made no attempts to keep the patient in bed. This dressing was repeated every morning, and on the second day it was noted that the ulcer had diminished one-eighth of an inch, and its granulations were more healthy in appearance. Two days later there was a decrease in length of one-fourteenth of an inch, and the granulations were on a level with the surrounding parts. As there was then but little discharge, I allowed the dressing to remain undisturbed until it became uncomfortable. This did not necessitate a change oftener than every fourth or fifth day, but the plan was not so favorable to the healing. Thus at the end of the first interval of five days, the ulcer had diminished only the one-sixteenth of an inch, and at the end of the next two intervals, one of six and the other of four days, there was no change whatever. I then returned to the original plan of renewing the dressing every day, with evident improvement in the first day. There was then some trouble in the ward, and this patient had to be expelled for the part she had taken in it.

CASE VIII.

Inflamed Varicose Ulcer two inches in diameter, of six months' duration, completely covered over by epithelium in six days, under dry earth and rest in bed.

Margaret S., a domestic, æt. 50 years, who had been suffering for some time with excessive varicose enlargement of the

veins of her legs, received a trifling scratch in August, 1868, on the inner side of the right leg, about five inches above the malleolus. From this there was developed an ulcer, which at the time of her seeking aid at the hospital, February 15th, 1869, measured two inches in diameter, and the tissues in its vicinity were much reddened and infiltrated. On admitting her, directed her to be put to bed, and have the dry earth applied with a roller, from the toes to the knee. The effect of the contact was cooling, and the pain diminished promptly. This dressing was renewed each morning, with not only perceptible but rapid improvement. Within one week the ulcer was well healed over, and the case presented a most promising appearance. The limb shortly after this became excoriated in three or four places as though the bandage had compressed the parts unevenly, and I had my suspicions aroused that the patient was not following my injunction to keep her bed. These points, however, quickly healed under the contact with the earth, but were followed by others in other places, and on inquiry of the patients in the ward, I found this woman was constantly on her feet about the room. The ulcer, in spite of this treatment on her part, became firmly cicatrized, and as I found she would not obey my direction, I had her discharged as a matter of discipline on the 6th of April.

CASE IX.

Extensive Lacerations of Fingers by a haycutter in a man of intemperate habits healed under Earth-dressings (daily renewed) in twenty-two days.

John W., æt. 35, a man of intemperate habits, got his hand caught, whilst feeding a haycutter, on the 15th of February. The accident resulted in severe laceration of the soft parts of the first phalanges of his thumb, index, and middle fingers, down to the joints. The bones were not crushed. He was brought to the hospital, a distance of some six miles, immediately after the receipt of the injury. With fine strips of gauze the lacerated parts were accurately adjusted and retained *in situ;* the fingers were then well covered with dry

earth. Its applieation was agreeable to the patient. The next morning the earth was removed, but not the gauze, as it was retaining everything in plaee. There was no tumefaetion. There had been no pain.

February 18th. The gauze was found loosened, and was therefore removed. There had been very little inflammatory aetion in the fingers. Earth-dressing renewed. The patient is allowed to be up and about. Has no pain.

February 22d. Margins of the lacerated parts were all noted on this morning as presenting healthy granulating surfaees.

The dry earth was eontinued, and renewed each day until the 6th of Mareh, when white elay was substituted. The thumb and forefinger were entirely healed on the 8th, and the middle finger on the 9th. The patient was then discharged.

CASE X.

A Sloughing Ulcer of five months' duration, from a heavy blow, on the shin; three inches in diameter—Reduced one-half in four weeks by partial rest in bed, with Dry Earth Dressings—No pain or complaint up to that time—Subsequent healing retarded by patient being constantly about on the limb—Discharged by request—Ulcer still unhealed.

Thomas J., æt. 28, was admitted on the 15th of February for a painful uleer of the right leg, the result of a blow from a pieee of railroad iron some five months previous. The ulcer was three inehes in diameter, in a sloughing state, and had resisted all previous treatment. No history of syphilis or other taint. The part was immediately eovered by the dry powdered earth, which was retained by Seultetus of paper, and the patient directed to keep his bed. The dressing he said, at the time, was eooling and pleasant; it was repeated every morning after the limb was washed. Under it the uleer quickly cleaned, and was redueed at the end of the fourth week by eontraction and eieatrization to just half its original size. Then the ulceration began to spread anew, and was painful, espeeially at night. On inquiry I diseovered that the patient was very constantly walking about on the limb. This I again forbade his doing, but after that time the uleer improved very slowly, and I had

every reason to believe from the condition in which I found his dressing every morning I examined him, and from accounts afterwards obtained from other patients, that he never obeyed my directions. There was, notwithstanding this, so much improvement that by the 14th of April the ulcer was in the condition in which it was at the end of the first four weeks of his sojourn in the hospital. The patient was nevertheless restive and discontented, and finally took his discharge by request on the 19th of May. The ulcer was then healthy in appearance, and was reduced to the size of an inch in diameter.

CASE XI.

Cancer of the Breast—Whole gland removed—Acupressure and serres-fines—Stitches—Gauze and Dry Earth—No pain—Rapid recovery—Photographed on tenth day—Wound all healed but one point, from which there was discharged two shreds of oakum—The subsequent progress very satisfactory—No return of the disease at end of three years.

Hannah C. was admitted to the hospital on the 12th of February for a scirrhous tumor of the right mamma.

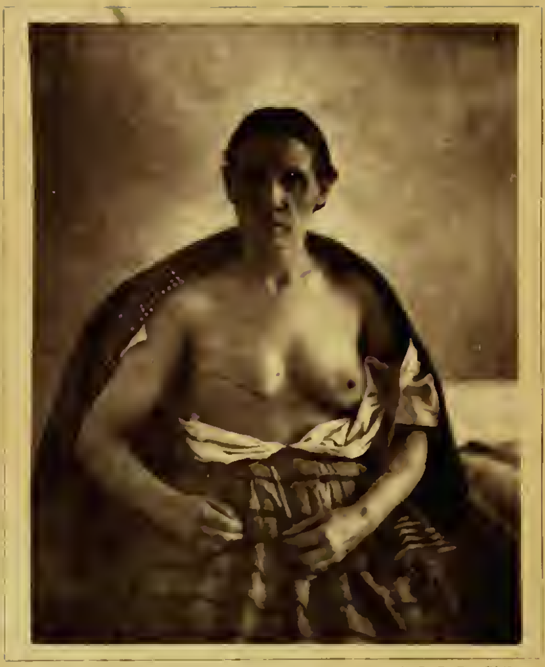
History.—Was born in Ireland; aged 41. Still menstruates. Has had three children; been a widow for five years; has no history of tubercle, scrofula, or carcinoma in her family. Had to work very hard (in a situation as a cook) last spring (1868), and in the month of May she noticed for the first time a small, hard lump in the right breast, outside of and close to the nipple. It has increased steadily since then without causing her any pain save when she had been using the arm a great deal, as at washing and ironing. Such exertions would be followed by a dull, aching pain in the tumor during the early part of the next night, but would be gone by the morning. Her general health has always been good.

Present Condition.—She presents to a slight degree the cachexia of cancer, otherwise she is apparently in good health. No functional derangements. No enlargement of axillary glands, nor of any of the lymphatic glands elsewhere. The nipple is not at all retracted. The tumor is a hard nodulated one of the size of a small pullet's egg, situated in the glandular

structure of the breast, beyond the areola, in the upper and outer quadrant of the breast. It is not painful, and becomes so only after she has been using the arm. Operation of excision of the whole gland was performed before the class at the hospital on the 17th of February. Two elliptical incisions were made to embrace the nipple and a narrow segment of the integument; the upper and lower portions of the skin covering the breast were then dissected off, and the gland completely enucleated. In doing this the knife was carried freely through the fascia and even the fibres of the pectoral. Two acupressure pins were sufficient to control the chief sources of hemorrhage; one on the branch of the long thoracic, the other in the upper flap, near the sternal end of the cut. Some smaller vessels were temporarily secured by serres-fines. These, eight in number, were removed in the course of an hour and a half, after the patient had thoroughly reacted from the ether. I then washed and mopped out with oakum the wound, and after applying some dilute sulphurous acid, ʒj to ℥ij of water, by means of the spray apparatus, I carefully adjusted and retained, by three leaden sutures and gauze and collodion, the margins along their whole length, leaving half an inch at either end as points of exit for any subsequent accumulation of blood or pus. When thus coaptated they formed a line of seven and a half inches, and a low estimate would allow over forty square inches of wounded surface to be healed. Dry earth was spread over the site of the breast, and retained by some pieces of white unglazed paper and a roller around the chest.

On the following morning the patient said she had been very comfortable as far as this dressing was concerned, but was annoyed by the effects of the ether; vomiting, headache, &c. She had a hypodermic of atropia $\frac{1}{40}$th, without any benefit. There had been but little oozing, not enough to get through the bandage. There was no pain. The earth was then washed off, and the two acupressure pins were removed (twenty-one hours after their introduction). Her pulse was full and strong, 92; temperature in left axilla $101\frac{1}{4}°$.

February 19th. She slept pretty well last night, having had a hypodermic of atropia. She is without pain. Her menstrual flow came on in the night, a week earlier than it should. There



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CASE XI.

Photographed on the tenth day after the operation.

has been but little discharge from the wound, and that of a sanious character. Two of the three sutures were removed. The gauze was forced from its place, but was renewed. I reapplied the earth. There was no fetor, no redness or tumefaction of the margins of the wound.

February 20th. Pulse 76, temperature $100\frac{3}{4}$°. Not over a drachm of discharge in last twenty-four hours. I removed the last suture. The gauze continued holding firm even after washing off the surface. The earth-dressing was renewed. There were no signs of inflammation.

February 21st. Pulse 86, of normal volume; temperature 103°. Slept very well last night after a hypodermic, at 10 P.M., of $\frac{1}{40}$th grain of atrop. sulph. Has some anorexia. Bowels not opened since the day of the operation; catamenia ceased in the night. Earth-dressing renewed after thorough washing.

February 22d. Had a good night's rest under atropia. Pulse 80, temperature $99\frac{1}{2}$°. Bowels moved early last evening without taking any medicine; appetite improving, tongue clean. Redressed with earth as before.

February 24th. Was out of bed yesterday. Removed gauze to-day, and found union firm and complete along all the margin, save at either end and at one minute point about the centre. From the last there was some discharge, and after a careful inspection I detected the end of what proved to be a shred of oakum, an inch and a half long, projecting from the point. This shred was no doubt left in the wound at the time of the first dressing. Renewed the gauze and collodion, and then the earth.

The earth-dressing was renewed every morning after washing, and no material change noted until the 27th. The appearance of the wound then can be best judged of by the accompanying picture, taken by photography on that day. The external angle of the wound was then discharging a small amount of purulent matter. "All the other portions of the wound seemed to be firmly united." General condition of patient excellent; no signs of inflammatory action.

On the 28th there was no discharge whatever apparent, and none appeared at any of the daily dressings until that of the

5th of March; then there was evidently some from the inner angle.

On the 9th a little pus could only be pressed out at this point; all the rest of the wound seemed firmly united. The gauze was removed, and the earth applied alone. No material change was noticed from that time till the 18th; the cicatrix appeared then to need some support; it was growing broad and bluish. I then used five strips of gauze, retained by collodion for the purpose. Her catamenia returned on that day, and were very profuse. She was directed to keep her bed. By the 23d, the cicatrix had given way at four points, and from them there was a free discharge. The parts around were quite sensitive; dry clay renewed. On the 24th she had a decided rigor, followed by fever and sweating, and the next day there was a copious discharge from all the openings, necessitating the reapplication of the dressing in the evening. By the 28th the whole cicatrix had given way, and an abscess was found to have formed, and another shred of oakum was found high up under the upper flap. After washing the surface off with a stream of tepid water, the earth was poured on so as to fill up the cavity. Its contact, the patient said, felt pleasant. The shred of oakum which had produced this abscess, was no doubt left there at the first dressing; it could hardly have gotten there afterwards. The use of oakum was entirely abandoned after the discovery of the first shred at the end of the week after the operation.

On testing the discharge the next morning, after removing the dressing and washing the surface, it was found to be decidedly acid. The dressing was renewed in same manner. The patient was allowed six ounces of milk punch per diem. Two days later the discharge, still very profuse, was found to be decidedly alkaline. The next day another shred of oakum was found in the bottom of the wound. The granulations were looking very healthy, and seemed disposed to coalesce. Two-thirds of the wound, at its inner part, were therefore supported in close contact by silver sutures, three in number, and the earth reapplied. At each succeeding day's dressing after this the discharge was found to be notably diminished, and its character was evidently healthier since the last shred of oakum came away. The patient's general condition was also improving, and

from this time until the patient was discharged, entirely well, May 11th, nothing occurred worthy of special note. The wound steadily cicatrized, having been filled from the bottom by granulations. Within ten days after the discharge of the oakum, the amount of suppuration on the granulating surfaces appeared reduced to a minimum, and so continued. Cicatricial tissue then began to form on the margins of the cut, and when she left there was a good firm cicatrix of five and a half inches in length, which had then been long enough perfect to remove all fear of its giving way again. The protracted recovery of this patient was clearly due to the unfortunate oversight by which some shreds of oakum were left under the flaps; we were in the habit of using it in the place of sponge. Accounts from this patient in January, 1871, nearly three years after the operation, show no return of the disease.

CASE XII.

Caries of Wrist-joint of some months' standing following an injury—Amputation through Forearm by Teale Method—Acupressure—Dry Earth Primary Dressings—Total absence of pain—No Sloughing—Rapid Union—Linear Cicatrix—Subsequent annoyance from Herpes recurring periodically, and evidently associated with Malaria.

J. F., æt. 26 years, was admitted into the hospital on the 19th day of February, 1869, for disease of the right wrist-joint. He stated that he had been a conductor on the Baltimore and Ohio Railroad, and that whilst engaged in coupling cars, eighteen months previously, his hand was caught between the bumpers and the bones were crushed, without the integuments being broken. Six or eight months after the receipt of this injury his medical attendant made a free incision into the wrist-joint and evacuated a quantity of pus. This opening was followed by extensive inflammation about the joint and the spontaneous discharge through other openings of purulent fluid. When he came to the hospital the joint was swollen to twice its natural size, was of an ovoid shape, with several fistulous openings communicating more or less directly with the carpus, filled with fungous granulations, and discharging an

exceedingly fetid pus. He stated that his general health had always been good, and that he was of temperate habits. He looked like a man who might have enjoyed the best of health, but was evidently much reduced by his recent sufferings. He was of medium stature, well formed, with dark hair and eyes, and said he used to have a ruddy complexion. He had suffered much from loss of rest, and was much reduced in strength and weight.

Dry earth was applied around the joint and retained by means of a Scultetus bandage of unglazed paper, and the arm supported by a rectangular splint. The fetor from the joint was immediately destroyed by the earth, and the patient obtained a good night's rest by means of a hypodermic injection of the one-fortieth of a grain of the sulphate of atropia. The layer of earth placed around the joint (about half an inch thick) was sufficient to keep the parts perfectly free from odor up to the time the dressings were changed the following morning, and the same was evident each subsequent day. He was allowed a generous diet, and by the end of four days there was an evident improvement both in his general condition and in the appearance of the joint. The subsidence of tumefaction and tenderness was then such as to enable us to give the joint a thorough exploration, and the result was a conviction on the part of my colleagues and myself that there was no remedy left but amputation through the forearm, from the fact that the bones of the carpus were in a state of caries and necrosis.

The operation was done on the 24th (of February) by Teale's method. To secure him as long a stump as possible, I made the dorsal flap so as to take in at its ulnar angle the margin of one of the fistulous openings. Three pins were used to control the hemorrhage. Those on the radial and interosseous arteries were applied by Simpson's fourth method; that on the ulnar by his third. The wounded surfaces were dusted with finely sifted dry earth from the hospital garden, and the patient was allowed to react thoroughly from the anæsthetic (ether) before closing them thoroughly. This was accomplished four hours after the operation was done; at that time noticing some oozing from the ulnar artery, I readjusted the pin originally applied to it, employing the same method as at first used. The

margins of the flaps were then (after their surfaces had been thoroughly freed of coagula and the powdered earth) carefully approximated and retained by the harelip sutures composed of glass-headed steel pins and silver wire, and the whole stump was well covered by the dry garden earth, which was retained by the Scultetus of dry paper, a rectangular splint, and bandage of muslin. The patient was put to bed, and given a hypodermic of one-fortieth of a grain of the sulphate of atropia.

On the following morning at my usual hour of visiting ($7\frac{1}{2}$ o'clock), he looked as bright and as comfortable as any one in the wards, and said that he had had an excellent night's rest; that he had not had a particle of pain in the stump since it was dressed, and that he would like to be allowed to get up and go out to smoke his pipe. This I of course could not for a moment consider. (The testimony of the other patients in the ward, and the patient's own confession to me, and that of others afterwards, prove however that he every night, even that immediately following the operation, had got up after the day-nurse of the ward had retired, went out and enjoyed his pipe as though nothing had happened to him.)

His pulse on this morning (that following the operation) was 80. Temperature $100\frac{1}{4}°$. General condition excellent. The stump was washed, the pins first removed from the radial and interosseous arteries, and the earth-dressings reapplied. Before leaving the wards I removed the pin from the ulnar. There was no bleeding from any of them. Those on the radial and interosseous were therefore removed at the end of $19\frac{1}{4}$ hours after their application; that from the ulnar at the end of 15 hours. Directed the dressing to be renewed twice a day, so as to keep everything perfectly dry.

On the second day the pulse was 88. Temperature $99\frac{1}{4}°$. He slept well without any anodyne, and has a good appetite. Had taken two bottles of porter and full diet.

There was considerable oozing from the angles of the stump. I removed the two central harelip pins to prevent tension, and to allow free vent to any inflammatory products, should they be formed. The dressing of dry earth was renewed after thorough washing of the stump. There is no pain or soreness except while the stump is being washed.

On the third day the pulse was 84. Temperature $98\frac{1}{4}°$. I removed all the harelip pins; the stump is looking well; there is not much serous oozing; no pus; I renewed dry earth-dressing after applying gauze and collodion to support the margins between the suture points.

On the fourth day pulse 72. Normal temperature 99°. Reported bowels as freely open in the night. Slept well; ate well. Renewed dressing after washing.

On the fifth day, stump looking very well, removed the wire of the harelip suture; found firm union at the radial angle, and to a considerable extent apparently along the main line of the wound. Did not, however, remove the gauze and collodion, as they were giving perfect support to the parts. Both pulse and temperature somewhat accelerated, the former being 80, the latter $99\frac{1}{2}°$.

On the sixth day (March 2d) after the operation I noticed, on uncovering and washing off the stump, some vesicles and rubefaction, especially on the extensor surface and over on the radial border. The stump was otherwise looking very well. Applied narrow strips of isinglass plaster instead of the gauze and collodion, as I thought the collodion might have caused the local irritation. Temperature and pulse prior to dressing noted $99\frac{1}{2}°$ and 84 respectively. Patient has not had a bad symptom or suffered any pain or inconvenience.

This eruption had not, however, in any way involved the wound, or interfered with its union. On that day the notes report the wound united throughout, save at a point in the centre, from which there was a slight discharge, and at the ulnar corner, which was originally a suppurating surface, having been made out of a fistulous opening.

On the eighth day I gave the patient permission to go out and enjoy his pipe. Everything was progressing nicely; the eruption occasioned him little or no pain whilst it was covered with earth. It itched him a good deal immediately after being washed, and before the earth was reapplied. The earth, he said, always relieved him of this itching, as soon as the part was covered by it.

This dressing was continued, being renewed, as originally directed, twice a day, up to the tenth day, when it was evi-

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CASE XII.

Photographed on the fifteenth day after the operation.

dently so unnecessary that I ordered the evening dressing to be omitted. The record of the twelfth day states: "The stump looking very well; scarcely any discharge from it;" the only part which did not unite directly (the ulnar corner), cicatrizing rapidly, dry *clay* now being used. Dressing renewed each morning.

The patient went, on the fifteenth day, and had his stump photographed. He had a return, two days before, of the eruption, noted as having shown itself first just seven days previous. This time it was on the flexor surface, and the photograph of that side shows it very distinctly.

On the eighteenth day I left the stump uncovered for an hour and a half, and then tested the chemical reaction of the discharge from the vesicles, and found it slightly alkaline. I suspended his porter, and gave him potass. bicarb. ℈j and d. Continued the dry clay dressing.

On the twenty-first day, the epidermis was found peeling off very freely where the herpes had been. On having my patient weighed on this day, it was ascertained that he had in the twenty days gained 20½ lbs. in weight. There was still some discharge from the ulnar corner, and from the small fistulous opening in the centre. The rest of the stump has remained firmly united throughout.

On the twenty-sixth day there appeared to be a portion of tendon protruding through the opening at the ulnar corner, and I applied wet earth to favor its separation, which took place at the end of three days, and a return was had to the dry earth dressings.

On the thirty-first day I tested the discharge from this opening, to determine the action of the earth on it. After washing the stump and drying it, I pressed some discharge from this point, and found by test-paper that it was also slightly alkaline. Sprinkling this discharge over with some clay, in sufficient quantity only to make a thin pasty mass, and then testing it, I found it had been rendered perfectly neutral. The clay removed on the following day, which had been moistened by the discharge from this point, was found also in the same neutral state. After the separation of the sloughing portion of the tendon, this opening at the ulnar angle healed rapidly,

and the patient continued steadily to improve in his general health; but I kept him for a long time in the hospital, on account of the successive attacks of herpes which he had in the stump. These recurred with great regularity on every seventh or fourteenth day, notwithstanding large doses of quinine were given both per orem and hypodermically, and with and without either dry or wet earth applied to the part.

To determine whether or not the earth-dressings had anything to do with the occurrence, I substituted the oxide of zinc ointment; but under it there recurred the eruption at the end of the week, and at the regular time, and absolutely a larger crop than even before. I then returned to the dry earth, and put my patient on the one-sixtieth of a grain of arsenious acid. Under this treatment he showed positive signs of improvement. The earth-dressing was abandoned, and the patient eventually discharged, on the 8th of July, with a most perfect stump.

TABLE OF PULSE AND TEMPERATURE.

Date.	No. of days after operation.	Pulse.	Temperature.
February 25,	1	80	100¼°
" 26,	2	88	99¼
" 27,	3	84	98¼
" 28,	4	72	99
March, 1,	5	80	99½
" 2,	6	84	99½
" 3,	7	84	100¾
" 4,	8	86	100

CASE XIII.

Ulcer of Leg, of six months' duration, from Varicose Veins—Dressed with Dry Earth and Clay—Rapid Healing—Operation on Vein twenty-six days after admission—No Irritation from Pins during a whole week of them remaining under the Vein—Result of Operation incomplete on account of Patient leaving the Hospital before Cicatrization was perfected.

A. C., an intemperate drayman, æt. 30, was admitted on the 20th of February for a varicose ulcer of the left leg.

History.—He had been suffering with varicose veins of the legs for many years, and about four years since one of these

burst for the first time, and healing, gave way again about two years and a half afterwards. The ulcer resulting from it healed after a time. Then another one formed in August last, and has been growing worse ever since. At the time of his admission it measured $2\frac{3}{8} \times 1\frac{1}{2}$ inches; it was angry-looking, with the skin for some distance around much excoriated.

It was then dressed with dry earth (subsoil), which the patient said was cool and pleasant. He was directed to keep his bed. On the renewal of this dressing for the third time (February 23), the ulcer was again measured, and found to be only $1\frac{7}{8} \times 1$ inch. A spiral from toes to knee was then added to the original dressing. This kind of dressing continued with steady improvement until the 8th of March, when I tried some clay, instead of the subsoil. This was equally agreeable to the patient when first applied, but in the afternoon it caused a burning sensation, which I considered due to the portion directly in contact with the ulcerated surface becoming pasty, and keeping in the discharge. Continued this clay, however, with benefit.

On the 18th of March I persuaded the patient to have an operation performed on the veins, with the view to a permanent cure of the cause of his trouble. The operation was made of passing two harelip pins under the saphenous vein without exposing it, about one inch apart, just below the head of the tibia. After effectually closing the vein by figure of 8 of silk over these pins, I divided the portion of vein between in a subcutaneous manner. Pulse 76, and temperature $99\frac{1}{2}°$, just before the operation. Dressed the leg with dry earth. Pulse the next morning 68, temperature $100\frac{3}{8}°$. No local irritation about the seat of operation. Has had no pain.

March 20th (second day). Pulse 66, temperature $99\frac{3}{4}°$. No pain or irritation. Nor was there any for the next four days. During these four days his pulse and temperature were as follows:

	Pulse.	Temperature.
March 21,	72	99°
" 22,	68	$99\frac{1}{2}$
" 23,	68	$99\frac{3}{4}$
" 24,	60	98

On the 25th, after I removed the pins, his pulse was noted to be 76, and temperature 100°. By measurement it was found that the distance between the points of entranee and exit for the upper pin had been two and a quarter, and for the lower one and a half inches. These points were slightly ulcerated. The vein seemed well elosed.

On the 26th both pulse and temperature were disturbed, and there was erysipelatous blush about all the points of ulceration. Pulse was then 76, temperature 101°. Earth-dressing continued.

On the 27th. Pulse 80, temperature 100°. Patient better.

On the 29th. Ulcer nearly closed. Mueh better in every respect. Continued to improve steadily. The points of the pins closed entirely, and the ulcer was almost eompletely cicatrized, when the patient, in eonsequence of some trouble with the nurse, asked for his diseharge (April 10).

CASE XIV.

Two Varicose Ulcers of Leg of two years' duration dressed with Dry Subsoil—No Pain—Rapidly healing and subsequent reopening of Ulcer—The Cure finally effected by the Earth.

James MeS. was admitted on the 20th of February for varicose uleers on the left leg. He was a single man, æt. 30 years, a baker by occupation, not strictly temperate in his habits; never had syphilis. The uleers, two in number, originated two years previously by small pimples, as he stated, on the inner and anterior surfaces of the left leg, direetly over the enlarged veins. These uleers had been increasing in size ever since. The upper one at the time of his admission measured $2\frac{3}{8} \times 1\frac{15}{16}$ inehes; the lower one $2\frac{9}{16} \times 1\frac{1}{2}$ inches. It was the seat of stinging pains. The patient was put to bed shortly after his admission, and had his uleers dressed with dry powdered earth (subsoil), which he said felt cool and pleasant when it was applied. The next morning he said his leg felt very well; no pain. The earth applied over half an inch deep had become saturated. On removing it by a stream of water, the ulcers looked much cleaner and healthier. The upper one had by ac-

tual measurement diminished in size $\frac{3}{16}$ths of an inch for its length, and $\frac{8}{16}$ths for its width. No appreciable diminution for the lower one. Earth reapplied every morning. Patient ordered to keep in bed.

A measurement on the 26th showed that the upper one was $1\frac{5}{16}$th inches long, and $1\frac{1}{8}$th inches wide; and the lower one $2\frac{5}{16}$th inches by $1\frac{1}{4}$ inches, that is, an absolute diminution in the six days' treatment of $\frac{7}{16}$ths for the length, and $\frac{3}{16}$ths for the width of the upper ulcer; and of $\frac{4}{16}$ths for the length, and $\frac{4}{16}$ths for the width of the lower ulcer. Two days later the upper ulcer measured $1\frac{4}{16} \times 1$ inch, and the lower $2\frac{4}{16}$th inches

The dry powdered subsoil was regularly reapplied every morning until the 6th of March. The ulcers were then reduced in size. The lower one was bridging across through its centre, and the upper measured $1\frac{4}{16} \times \frac{10}{16}$. On the morning of that day I substituted some potters' clay for the subsoil; this felt like the other when first applied, but in the course of the day it seemed to create some burning and itching. As it did not, however, seem to disagree with the ulcers, its use was continued.

In the course of the following week the patient did not seem as well as he had previously been. He had some febrile excitement; complained of his leg and foot becoming painful; some swelling and redness showed themselves; then a depot of pus formed on the dorsum of the foot; this was opened on the 18th; another was detected just below, and on the inner side of the knee; and still another immediately above the knee. The patient, with the onset of the symptoms which preceded these formations, was put on the tr. ferri chlor. thrice daily, and dry clay dressings as before. After the evacuation of the abscesses at the knee, on the 29th, wet clay was applied. But the next day we returned to the dry clay, as more agreeable to the patient and a better disinfectant. The patient improved steadily from this date, and no change was made in the treatment until the 14th of April. I then retained the clay in contact with all the granulating points by strips of adhesive plaster (after Boynton), and applied a spiral bandage, and the patient was allowed his liberty about the ward in a wheeled chair on the 16th.

No material change was then noted till the 22d, when the

lower ulcer was stated to be healed over, save one small spot. The patient had been walking about as much as he pleased for two or three days. In the course of three weeks all the ulcers and the openings made on the foot and below the knee were closed, but the opening above the knee was still discharging in a trifling degree.

May 28th. The cicatrices of the original ulcers have all given way in the last twenty-four hours. The patient had been about without any supporting bandage. Dry earth reapplied, and continued daily. Application made by adhesive strips as before, and a spiral. Dissatisfied with the idea of staying in bed, was therefore given the liberty of the ward. The ulcers cicatrized very slowly under the circumstances. They were, however, eventually healed in a thoroughly firm manner, and the patient discharged by July 7th.

CASE XV.

Shell Wound—Burning Face and Hands—Lacerating Leg and Knee—Dressed with Dry Earth—No pain from this Dressing—Profuse Suppuration—Testing Power of Earth—Pyæmia—Patient removed from hospital, in a dying condition, on twentieth day.

Wm. H. was admitted on the 20th of February, for injuries sustained the afternoon previous from the explosion of a shell. The patient, a boilermaker by trade, æt. 41 years, was handling, in the shop where he worked, some old iron, amongst which there was a shell, supposed to have no charge in it. Striking it casually an explosion ensued, burning his face and hands in first degree, and producing, besides an extensive laceration of the left leg, a compound fracture of the patella. At the time of his admission, it was thought by the resident, from the small, circumscribed character of the wound over the patella, that the knee-joint was not open. It was, therefore, determined to attempt to save the limb. The edges of the wounds were all brought together, and retained in apposition by leaden stitches, and the limb then enveloped in powdered earth, retained by a Scultetus and spiral from the toes to the pelvis; was put on an inclined plane. The burns were all well

covered with the powder. No pain. A hypodermic was then given. The patient, although he claimed to be a healthy man, acknowledged to being intemperate in his habits.

February 21st. Slept "right well" all night; no pain. Pulse this morning 68, strong and full, temperature 102°. Did not disturb the limb. Allowed eight ounces whisky per diem.

February 22d. Had a comfortable night without any hypodermic. Pulse 72, temperature 101°. Tongue somewhat furred; no nausea or chill. Removed the dressings. Very little inflammatory action as yet about the joint. Dressed as before.

In the next three days the evidence of the joint being implicated became very definite. Pulse rose to 114, full and strong; temperature, 104¾°. The wound opened and discharged quite freely, and the pus burrowed beneath the integuments on outer side of the limb, as far down as the head of the fibula.

On the 26th there was a very decidedly erysipelatous blush along the leg and outer side of foot, and their tissues were all very much swollen. Temperature of the leg five inches below the knee was 103¼°. His sufferings were aggravated in the night by the pressure of the splint at one point on the thigh. Made an opening on outer side of leg, and discharged considerable pus. Then enveloped the limb as before, and suspended it by Smith's anterior splint.

February 27th. Swelling and redness of leg diminished very decidedly. Wound discharging profusely; patient emaciating. Pulse 100, full; temperature 102°. Earth reapplied; destroys completely the fetor of the discharge.

February 28th. No odor about the bed before opening the dressings. Pulse 126, weak; temperature 105¼°. Anorexia, nausea, and vomiting at sight of breakfast this morning. Diarrhœa in the night.

The limb looking better, continued dressings. Ordered 10 drops of dilute sulphuric acid every two hours. Increased stimulant to 12 oz. of whisky per diem.

On the night of the 2d of March (ten days after the accident) had a severe rigor. Got shortly afterward a hypodermic of atropia, after which he slept very well. The next morning

there was a profuse discharge from the knee. Skin moist; tongue dry. Pulse 116, temperature $101\frac{1}{2}°$.

From this day, symptoms of pyæmia became more and more marked. Frequent rigors, vomiting, diarrhœa, sweetish odor from breath and perspiration; dry and brown tongue; dysphagia, with most profuse discharges of ichorous pus, at each morning's dressing. The power of the earth as a disinfectant was well shown. As long as the earth was in a measure and prevented the escape of the discharge, there was no odor of pus about the limb. The patient never complained of the contact of the earth; was always, however, fatigued and pained by the act of being dressed.

He was removed from the house in a moribund condition, on the 12th of March, twenty days from the day of the accident.

CASE XVI.

Chopart Amputation done ninety miles from Philadelphia—Ligatures and stitches—Dry earth—Second day rapid healing—Some trismus on 14th day—Hypodermics of Aconite—Recovery.

W. C., a Welsh miner, æt. 35 years, was brought to the Pennsylvania Hospital on the 22d of February, from Hokendauqua, Lehigh County, Pennsylvania (a distance of about ninety miles), where he had on the day previous been subjected to an amputation (Chopart) on account of injury, caused by a cinder car passing over the foot. Five silken ligatures had been used to arrest the hemorrhage, and the margins of the flaps were retained in accurate approximation by silken sutures. On his admission into the hospital dry earth was applied without in any way disturbing the ligatures or sutures. This dressing proved very acceptable to the patient, relieving him, especially when first applied, of the pain. Hypodermics of one-fortieth grain of atropia were ordered at bedtime to procure sleep. Full diet. With this treatment he made very good progress. In four days' time all the ligatures had separated save one; the appetite was then noted as good; bowels regular; sleep pretty good. The remaining ligature came away on the next day.

March 1st. It was noted that all the parts looked quite healthy, save at the inner angle, where there was some disposition to slough ; general condition good.

On the 8th, dry clay was used instead of the earth. Cicatrization was then progressing rapidly ; the patient was up in the ward chair nearly all day.

On the following day he complained of some stiffness of the muscles of the lower jaw, and some sharp pains in the lumbar region. On the 10th these pains became more marked ; they were, however, then relieved by the hot water bag to the spine, but on the morning of the 11th, he could scarcely open his mouth more than half an inch. There was *no* appreciable change in the condition of the stump ; there was *no* increased sensibility ; discharge free and apparently healthy in all its characters. During the night previous he was awakened from his sleep (he had had one-fortieth grain of atropia) several times by paroxysms of pain. As he was awakened by these paroxysms he on each occasion bit his tongue quite severely by the spasmodic contractions of the jaw. Tongue slightly coated. Pulse 74, temperature $99\frac{3}{4}°$. At ten minutes past eight o'clock this morning he had a hypodermic of twenty minims of a solution of the tincture of aconite root (gtt. xij to ℥ss.). In ten minutes' time his pulse was 60, temperature $100\frac{3}{4}°$. Twenty minutes after this injection, pulse was 56, temperature, 100.° In thirty minutes' time, pulse 70, temperature same. The acceleration of pulse was quite possibly emotional, and due to my interrogating him, for ten minutes later when I was not near, it was 56, and continued so until after seventy minutes had elapsed, when the last observation was made ; he had then been for fully thirty minutes quite free from pain. At 4.30 the hypodermic of the same quantity of the aconite tincture was administered, and another at 9 P.M., with similar reductions in the frequency of the pulse. An hour later one of the one-fortieth grain of sulphate of atropia was given, after which he slept pretty well through the whole night.

March 12th. Pulse 66, temperature $100\frac{1}{4}°$. Stump dressed with clay ; looking very well ; at 8.40, had the hypodermic of aconite ; fifteen minutes after then, pulse 60, temperature $100\frac{3}{4}°$. Whole body covered by a profuse sweat, which came out a few

moments after the injection was administered. This sweat was decidedly acid. At the end of the hour this sweating had ceased, and the pulse was 56. Was free of pain and stated that he had had less pain the last night than the night previous. At 1 P.M., pulse was 70, temperature $98\frac{3}{4}$,° and skin bathed with cold sweat; got another hypodermic of aconite at 4.40 P.M., another at 8.40, and one of atropia at bedtime.

March 13th. Was quite free of pain last night. Pulse this morning before dressing was 76; temperature $100\frac{1}{2}$°. After dressing stump with clayey earth as heretofore, he had the hypodermic of aconite; another at 1 P.M., at 5, and at 9 P.M., but no atropia.

March 14th. Slept well last night; was free from pain; had, however, some spasmodic twitchings in the legs; cannot open the mouth any wider. Pulse 82, temperature $100\frac{1}{2}$°; stump doing very well; same dressings. Aconite injections repeated as on the day previous, with similar effects.

March 15th. Aconite injections omitted this day, but gave one of atropia at bedtime.

March 16th. Pulse 64, temperature 100°. The stump was recorded on this, the twenty-second day after the amputation, as united completely save at the inner angle, where it was, however, granulating nicely. Testing the discharge from this point showed it to be highly alkaline, immediately after the earth, which had been on twenty-four hours, was removed. On dusting some fresh clay on this point, and then washing it clean, this alkalinity was found to have been destroyed. There was still some stiffness in the back and jaws. Ordered two hypodermics of aconite, one after the dressing was made, and one in the evening. The same effect was noticed from these as from those of previous days, namely, a decided reduction in the frequency and force of the pulse.

March 17th. Pulse early this morning was 68; temperature 99°. Subsequently (about noon) the pulse rose to 72, and temperature 100°. Had the aconite as on the day previous, but was not given any atropia at bedtime.

March 18th. Slept well last night. Has not so much stiffness or pain as he had two days ago. Dressing renewed as heretofore by washing off with tepid water that of the day

previous, and applying the sifted earth, which was retained in place by a Scultetus made of strips of white bibulous paper. Aconite injections morning and evening.

March 19th. Still improving; pulse 70, temperature $100\frac{1}{4}$°. Still less rigidity; no change in treatment. During the evening of this day he was noticed to be sweating profusely, with a pulse of 72, and temperature of 100°.

March 20th. Pulse 76, temperature $99\frac{3}{4}$. No material change in condition. "Stump looking remarkably well;" no change in treatment, save that of omitting the aconite during the morning. In the evening he had a great deal of pain in the back; pulse was then 84, temperature $101\frac{1}{4}$°; had then given a hypodermic of aconite.

March 21st. Pulse 72, temperature 101°. Ordered to-day hypodermics of atropia (one-fortieth grain) morning and evening; no aconite.

March 22d. Pulse 84; temperature 101°; slept well; stump looking very well; same treatment as on 21st.

March 23d. Pulse 76; temperature $100\frac{3}{4}$°; doing very well in every respect. From this date there was nothing recorded worthy of note, until 28th, when the stump was recorded as entirely healed. No pain; patient up and about the ward On the 1st of April he was discharged completely cured.

CASE XVII.

Fungus of Testicle excised by Ecraseur—Dressed with Dry Earth—No pain—Wound healed in two and a half weeks.

A single man of 27 years, residing in one of the rural districts of our city, where he followed the occupation of an operative in a hosiery factory, applied for admission into the hospital, on the 24th of February, for a fungus of the right testicle. He had contracted a chancre in 1863, which was followed by buboes in both groins; the one in the right maturated, the other underwent resolution. Two months after this he had a well-defined syphilitic eruption. Then, in June, 1865, the right testicle became enlarged, and a month later the left one

became similarly affected. The latter resumed its natural size in the course of six weeks; but the former continued to increase, and eventually, in the spring of 1866, it opened, and discharged steadily for some time. It then closed, reopened, and closed again, whilst under treatment.

In the beginning of 1868 it opened for the third time, and had continued so ever since. The fungus, at the time of his admission to the hospital, was about $2\frac{1}{2} \times 2$ inches, with a rough, irregular, granulating surface, projecting half an inch above the integuments. This fungus was firmly connected with the gland, which was considerably enlarged. The patient's general health was very good.

On the 3d of March I removed the gland, with the fungus, by the écraseur, having previously enucleated it by two elliptical incisions, which, when brought together, gave a linear measurement of $3\frac{1}{2}$ inches. The operation was done with the patient under ether. To prevent the retraction of the stump of the cord, I secured it *in situ* by a large acupressure pin passed under it, by Simpson's first method, and a figure of 8 of wire. When all oozing had ceased, I coaptated the margins, and secured them in contact by a kind of harelip suture, which consisted in adding, on either side of the wound, a piece of wire, the length of the cut, so placed under the heads and points of four harelip pins as to give pressure throughout their length when the figure of 8 was passed over the latter. The whole scrotum was then covered with dry powdered clayey earth, retained by narrow strips of paper and a suspensory bandage. The patient was removed to his bed, and given at bedtime a hypodermic of $\frac{1}{40}$th gr. of sulphate of atropia. He had had no pain up to the time of getting this injection, since the operation. An examination of the gland showed it to be completely disorganized. The next morning his pulse was 82, temperature 101°. He had had a good night's rest. No oozing. Dry earth dressing renewed. No pain.

March 5th. Pulse 94, temperature $101\frac{3}{4}$°. But slight tumefaction of scrotum. No discharge; no pain. Cut across the figures of 8, but left them *in situ*. Renewed the earth-dressings. Repeated the hypodermic at bedtime. Slept well the night before from it.

March 6th. Removed all the pins this morning, including the large one passed under the cord, as it had evidently excited sufficient inflammation to effect the purpose for which it was used. The patient had not any rest the night previous. His pulse was 80, temperature 100½°. Dry clay renewed. No pain.

On the 7th (the fourth day), patient reported having had a good night's rest from the atropia. Appetite good; tongue clean. Bowels regular since operation. Pulse 80, temperature 99¾°. Dressing renewed.

On the 8th, the wound noted "as united, save at one point of an inch in length in centre, through which there is some discharge." Dry earth dressing renewed. Tumefaction of scrotum rapidly subsiding.

On the 9th, the discharge noted as more abundant than it has been. Tumefaction gone.

At the end of the second week the patient was up and about. There was, however, quite a free discharge from the central point, which was well filled by healthy granulations. Its margins were then secured in closer contact, by two deep sutures of silver wire. Dry earth continued.

Patient discharged cured, with wound well cicatrized, on 29th, two weeks and a half after the operation.

J. C., CASTRATION FOR SYPHILITIC FUNGUS.

Date.	No. of Days.	Pulse.	Temperature.
March 4,	1	82	101°
" 5,	2	94	101¾
" 6,	3	80	100½
" 7,	4	80	99¾
" 8,	5	80	100¼
" 9,	6	100	100
" 10,	7	86	99¾
" 11,	8	84	100¼
" 12,	9	92	98¾
" 13,	10	76	97

CASE XVIII.

Fistula in Ano—Divided by Syringotome—Dressed Wound with Dry Earth—No special effect.

On the 25th of February I operated at the hospital clinic on J. W., aged sixty-five years, for fistula in ano, with which he had been suffering for several months. He attributed its origin to a bruise. I found the inner opening as usual just within the sphincter; the outer one was an inch and a half from the verge. I laid the track open with a syringotome, and after the bleeding had ceased I dusted the wound over with dry clayey earth. This was repeated every day until the patient was discharged, with the wound firmly cicatrized, on the 25th of March.

CASE XIX.

Two crushed Fingers in a Child of six years, requiring Amputation—Torsion—Earth Dressing—No pain—Direct Union completed within thirteen days.

John L., a child of six years of age, was brought to the hospital on the 28th of February, having just had his left hand injured in a cotton factory. His forefinger and middle finger were both so mangled as to necessitate amputation; the former at the first joint, and the latter at the metacarpo-phalangeal articulation. Dry earth was used as the dressing after the hemorrhage had been arrested by torsion. The dressing was renewed every day, and by the 9th of March (the eleventh day) the stump of the forefinger was entirely healed; so on the 11th (thirteen days after the accident) with the middle finger, and the child was discharged on that day with two excellent stumps. Never seemed to experience any pain whilst the earth was on

CASE XX.

Lacerated wound of Forehead in a Child five years old, from kick of a horse, uncovering the Os Frontis—Rapid healing of wound under Dry Earth—Subsequent abscess, with exposure of Bone—Gradual Cicatrization of the Wound without Exfoliation of Bone under the same Dressing.

Thomas G., æt. 5 years, was kicked on the forehead by an unshod horse, on the 3d day of March. He was conveyed to the hospital immediately after, and presented a lacerated wound of a semicircular form, and two and a half inches in length, situated to the left of the median line, about one and a half inches above the eyebrow. It extended down through the periosteum, so as to expose the bone. Its convexity was upwards. There were no evidences of injury to the bone, or disturbance of the brain.

The margins of this wound, after being thoroughly cleaned, were accurately coaptated, retained *in situ* by gauze and collodion, and then covered with some dry earth, which was retained by a roller. This dressing remained on for five days, with the renewal of the earth only each morning. Its application always seemed agreeable to the child. At the end of that time the gauze was renewed, the wound looking as though it had united throughout, and the dry earth was continued. At the end of the week, however, there was some redness and puffiness at the lowest point. These developed into a small abscess, evidently the result of pent-up coagulum, for which a small opening was made on the 16th (thirteen days after the accident), and the dry earth renewed as before, with the effect, evidently, of destroying the pain of the cut. The discharge from this opening continued for some time, and I had fears from its burrowing that there was probably some exfoliation going on; I therefore, on the 28th, resorted to the use of wet clay, so as to favor suppuration. The opening then enlarged, and the bone could readily be perceived on the 19th of April, denuded of its periosteum. Dry earth was then resorted to. Under it the ulcerated opening contracted, and eventually (by the 1st of June) became firmly cicatrized, without any bone being previously thrown off.

The patient was discharged completely cured on the 5th of June.

CASE XXI.

Phlegmonous Erysipelas with Extensive Sloughing of Cellular Tissue of Forearm, the result of a trifling injury, three weeks before admission—Deodorizing power of Earth on the Fetid Abscesses well shown, but its failure to prevent contamination of the air of the ward by the emanations during the dressings.

John G., æt. 35, a laboring man, was admitted on the 4th of March. Three weeks prior to his admission he had his middle finger of the right hand, near its last phalangeal joint, lacerated to a trifling degree. The wound did very well for a week, when the forearm began to swell, and presented, according to his description, the appearance of erysipelas. Just before his obtaining admission to the hospital, a small opening formed below the elbow on the outside of the forearm, and gave exit to some fetid matter. The inflammation had never extended above the joint. The patient's condition was bad; he was emaciated and anæmic, said he had suffered a great deal, especially before the opening occurred at the elbow; this, however, has given him but slight relief; he was unable to rest at night on account of his pain. The evidences of an extensive collection of pus were so marked over the line of the ulna on the dorsum of the limb, that I made a free incision through the integuments there, and gave exit to some four or six ounces of exceedingly fetid pus. This opening was made in the amphitheatre before the class, and anticipating the character of the discharge I had provided a basin with some earth in to receive it, and thereby make a demonstration of the earth's disinfecting power. The nauseous odor from the stream, as it flowed into the basin, rapidly diffused itself through the room, so that all there had the opportunity of perceiving it. When the matter ceased to flow, that which had been caught in the basin was covered by the earth, and the basin was sent round the class, to enable them to judge by close examination whether the smell had been entirely destroyed. There was nothing perceptible about it beyond the odor belonging to wet earth. Some of the earth thoroughly wetted with the discharge, and rolled into a ball in my hands, did not emit any odor of pus. There was still a stench from the opening, but on separating its lips (it

was full three inches long), and packing it with dry earth it ceased to emit any odor. The whole forearm and hand were then covered as well as possible with the earth to the depth of half an inch, and retained by the Scultetus bandages of waxed paper; then a rectangular splint was applied. The patient expressed himself as very much relieved, and was positive in his assertion that the contact of the earth with the wound removed the pain from it.

The next morning his pulse was 64, temperature 100¼°. He had slept well the night through without any anodyne, and said he had not slept any for the week previous. The tumefaction was very much diminished, the pus had run through all the dressings on to his bedding, and its fetor was perceptible all through the ward. After washing the limb I found another collection of pus on the inner aspect. This I incised freely, and gave vent to the same kind of matter. The effect of the earth in allaying the pain of the wound as great as in other cases. The patient was then ordered tr. ferri chlor., gtt. xx, four in d.; full diet, and four ounces of whisky, and a hypodermic of sulphate of atropia ($\frac{1}{40}$th of a grain). Dry earth dressing to be reapplied twice a day.

March 6th. Pulse 74, weak; temperature 102°. Slept well last night. Discharge escaped, but not to same extent as before. On washing, long shreds of connective tissue came out of the openings. I used dry yellow clay in place of the earth, applied in the same way as a dressing. Its disinfecting power well shown when put into the openings, which still emitted a fetid odor when uncovered. This clay was made to envelop the limb by a Scultetus made of unglazed paper. No waxed paper was put on at this dressing.

March 7th. Pulse 74; temperature 101¾°. Patient slept well last night without his soporific (sulphate of atropia); was asleep before the time had come round for him to get it (10 P.M.).

For the next two days the discharges were so profuse and fetid that the earth-dressing had to be reapplied three times in the twenty-four hours. His pulse ranged from 78 to 100, and temperature from 102¼° to 104°.

The report of the morning of the 10th was, that he had slept all night; was entirely free from pain. Pulse 74, nearly normal

volume; temperature 102°. Discharge so much less that it was not necessary to re-dress it during the day. That night he got the hypodermic of atropia, but did not sleep after 12 o'clock. His arm was so painful he begged to have it dressed more frequently, as it was always free of pain when the earth was just put on.

During the next ten days he improved very rapidly. He was about the ward and out of doors by the 13th. He picked up in flesh; his wounds were all cicatrizing; and he was so well that he went home several times on a pass, and finally took his discharge on the 21st, although he was not entirely cured, for there was then one point not completely cicatrized.

We attributed much of the bad condition in which many of the cases in the ward with this man got after his admission to his having contaminated the air there.

CASE XXII.

Deep and Extensive Scald of the Scalp and Shoulders treated for the first four days with Sweet Oil and Lime Water—Great Pain and Fetid Discharge—Dry Earth then used with immediate relief of both Pain and Fetor—Complete Cicatrization of the Ulcerations after seven days' use of the Earth-dressings.

A woman, æt. 24, was scalded on the 4th of March by the upsetting of a tub of boiling water, which she was raising on a dumb-waiter. The water came directly over her head, making a very thorough and deep scald of the scalp, neck, and shoulders. Immediately on the receipt of the accident her mistress had lime-water and sweet oil applied over the parts. This dressing was renewed every morning for four days without any appreciable relief to the patient. Her sufferings were very great during those days, and not having had any anodyne she got no rest. She then sought admission to the hospital. On examining her it was found that the whole surface of the scalp was suppurating freely, and discharging "a very fetid pus." After trimming off the hair, the whole surface was well covered with dry earth. This, she said, afforded immediate relief. The application also had the effect of removing the fetor. A bandage

was applied to retain the powder as closely as possible *in situ*. The patient had a good nap that morning, shortly after the dressing was completed, and without the aid of any anodyne. The following night she got a hypodermic of $\frac{1}{40}$th of a grain of sulphate of atropia. With this she slept soundly the whole night through. The next night she did well without any anodyne, and by the 15th, seven days after her admission, the whole scalp had entirely skinned over under the daily repetitions of the dry earth dressings, and the patient was given her discharge on the morning of the 16th, twelve days after receiving the injury. At each morning's dressing the scalded surfaces were thoroughly cleansed with tepid water.

CASE XXIII.

Strumous Abscesses of Inguinal Glands freely opened—Covered and subsequently stuffed with Dry Clay—Completely healed in sixty days.

On the 6th of March I opened three suppurating lymphatic glands in the vicinity of the right saphenous opening of a delicate-looking girl, 9 years old. The glands had been diseased for some time, and yet when the openings were made, fluctuation was but indistinctly perceptible in them. I rendered the parts insensible by the ether spray, and then laid them open by free incisions. The patient experienced no pain whatever during the operation, and when she began to suffer with the burning pain, characteristic of the reaction from the freezing, I covered the parts with dry powdered clay, which she said took the pain away. This dressing I retained by a bandage.

The next morning she was entirely free from pain. The dressings were removed, and it was found that there had been but little discharge from the openings. Renewed the dressing as before.

This was done every morning in the same way until the 25th of March, when I found on examination that the openings were very much disposed to close, and the matter was burrowing up toward the ilium. I then directed that the cavity should be well packed with the clay every day. This, when I examined

the case again after a lapse of three days, had evidently had the effect of arresting the burrowing; and, furthermore, before this mode of dressing was adopted, there was always noted a decided fetor from the openings when the earth was removed, but afterwards it disappeared entirely. The cavities then began to contract and fill up. This process went on slowly, however, although the child had had six ounces of punch, three grains of sulphate of quinia, and three drachms of compound syrup of phosphate regularly every day from the time of her admission into the hospital.

By the 10th of April she was so far well as to be up and about the ward. Firm cicatrization was finally effected by the 6th of May. No other dressing was used than the clay, and the child not only never complained, but, on the contrary, satisfied me that it was always comfortable to her. She left the institution May 6th.

CASE XXIV.

Penetrating Wound of Knee-Joint by Broken Glass—Closed and covered by Dry Earth—Extensive and Offensive Suppuration from Joint—Disinfecting Power of the Earth fully demonstrated—Death on fourteenth day.

Charles W., a German, æt. 38 years, was attacked, on the evening of the 7th of March, by some ruffians, eight or ten in number, and whilst in the act of running from them he was struck on the outside of the right knee by a porter-bottle, and had thereby produced a lacerated wound over the joint. He was immediately after conveyed to the hospital. The case was reported to me, the following morning, as an ugly wound of considerable depth, but without any proof having been obtained of its penetrating the joint. It had been carefully closed and covered with earth immediately after his admission, with the effect of soothing the pain. I removed the dressing sufficiently to see the condition of the knee, and not discovering any tumefaction or tenderness, I simply reapplied the earth. That night—twenty-four hours after the injury was inflicted—the patient complained of pain in the joint. For this he re-

ceived a hypodermic of atropia, $\frac{1}{40}$th grain, which, he said the next morning, had given him a comfortable night. The knee was then somewhat swollen, and tender to the touch over the seat of the wound, but not elsewhere.

On the 11th he was still suffering from the pain, and began to have diarrhœa, which latter was checked in the course of twenty-four hours by two-grain opium suppositories, of which he got four in that time. Unmistakable signs of inflammatory action in the joint were then present.

These were still more marked on the 12th, and the patient had had no relief the night previous from the atropia. On opening the wound and exploring it with my index-finger, I found two pieces of glass imbedded in the condyle of the femoris, and by making a free incision near the outer hamstring, I gave vent to a very offensive discharge from the joint. As this discharge was caught in a small vessel having some dry powder earth in it, its odor was completely destroyed.

The patient's pulse before this operation was 88, temperature 103°.

March 14th. Patient had a severe chill in the night, followed by profuse sweating. After this he slept pretty well, from effects of atropia. Pulse 104, full; temperature 105$\frac{1}{4}$° Had considerable nausea. Tongue somewhat furred. No diarrhœa. Knee much swollen, and very painful. Earth continued.

March 15th. Pulse 88, temperature 102°. Slept well last night, after $\frac{1}{30}$th of atropia. Vomited several times during yesterday, the knee discharging very freely, sufficient to require dressing twice in twenty-four hours. Was ordered: Tr. ferri chlor., gtt. xx; quin. s., gr. ij, 4 in d.; acid sulphurous, gtt. x, t. d.

Whisky and beef ess., freely. Earth-dressings continued. Produce no irritation or pain, and act most efficiently as a disinfectant to the discharge.

March 17th. Pulse 110, very feeble; temperature 103°. Slept pretty well without any anodyne. Some nausea. No diarrhœa. Tongue moist, but furred. Enlarged the wound to give freer vent for all accumulation in joint; then placed the limb in a long box, and covered it with dry powdered earth.

The report on the 18th was that he had a chill yesterday, in the morning. Was very weak. Pulse 120, temperature 100$\frac{1}{2}$°.

Slept pretty well during last night. A sweetish odor about his breath. Wound discharging very freely; dressed as on yesterday.

March 19th. Pulse 124, temperature 101°. Whole limb very much swollen and reddened, particularly on posterior surface. Made an opening, about three inches above the original wound, on the posterior aspect of the thigh, and discharged a large quantity of broken-down blood and pus, which was very offensive. The power of the earth to disinfect thoroughly shown on the discharge this morning.

Dressed the limb as before.

The next morning, March 20th, the patient was evidently moribund; was not disturbed, and expired at 6 A.M., on the 21st.

CASE XXV.

Injury from Circular Saw—Loss of Index Finger, and Laceration across palm of Hand—No Hæmostatic employed—Stitches of Silver Wire—Gauze and Collodion—Dry Earth, Clayey, as Dressings—Secondary Hemorrhages on and after sixth day—Arrested by Acupressure—All the Wounds healed in thirty-three days, under constant use of the Earth-dressings.

F. A., æt. 26, a German laborer, had his left hand lacerated by a circular saw, on March 8th, 1869. He was immediately afterwards conveyed to the hospital, where it was found necessary, in consequence of the extent of injury, to remove the index finger at the metacarpo-phalangeal articulation. The laceration extended also across the palm, from that finger to the base of the ring finger. There was some bleeding, but the application of dry earth seemed sufficient, after the parts had been well coaptated, to arrest it. The patient obtained at bedtime a hypodermic of $\frac{1}{40}$th of a grain of atropia, which made him rest perfectly well. The stitches of silver wire were removed on the 11th; but the gauze, with collodion, which had also been used for the purpose of effecting coaptation, was not disturbed. There was but little or no discharge of any kind up to this time. The dressings of dry clay had been renewed each morning, and were always cool and agreeable to the patient.

During the 14th and 15th there were frequent recurrences of slight hemorrhage, amounting in all, however, to a considerable amount. They were accompanied by a burning pain; that of the 14th was sufficient to completely detach the gauze. On the 15th it was noticed, after the hand had been washed, that "the injured surface of the palm was granulating nicely." During the morning of this day (the 15th) it was definitely determined that the bleeding came from the digitals of the index finger; the stump was therefore opened, and the orifices closed by acupressure, one pin being used to secure both vessels. The dry clay dressings were continued.

The acupressure pin was removed on the 17th, without the return of any bleeding at the time. Testing the discharge from the granulating surface of the palm some time after the earth had been washed off, it was found to be very slightly alkaline. On dusting the surface over with some dry clay, and immediately washing it off, both litmus and turmeric papers showed the surface was neutral in its reaction.

In the afternoon of this day, March 17th, he had a return of the hemorrhages. They were arrested by an acupressure pin applied to the radialis ind. by the first method, without disturbing the flaps covering the end of the bone.

On the 18th the pulse was noted as 90; his temperature, $101\frac{1}{4}°$. He had had a good night's rest without any anodyne. The acupressure pin was removed (twelve hours after its introduction); no bleeding; dry earth dressings as before.

On the 19th test paper showed the discharge, which formed after washing off the earth, to be acid, and this was rendered neutral by sprinkling some clay over it. The patient's appetite good; bowels regular; pulse, 84; temperature, $99\frac{1}{2}°$.

Being restless that night, he got a hypodermic of atropia, $\frac{1}{40}$th of a grain.

On the next morning (that of the 20th) his report was that he had had a very good night's rest. Pulse, 104; temperature, $100\frac{3}{4}°$. Parts all looking very well; dry earth continued.

On the morning of the 21st, having slept well the night previous without any atropia, his pulse was only 68; temperature, $100\frac{5}{8}°$.

From this date there was no evidence whatever of any dis-

turbance, of either a local or general character. All his functions were performed properly, and he was well enough to be out of bed all day on the 25th.

By the 1st of April (twenty-third day after injury) "the wound on palm had almost completely cicatrized," and by the 10th everything was healed up, and the patient was discharged from the house.

F. A.'S SECONDARY HEMORRHAGES.

Date.	No. of Day.	Pulse.	Temperature.
March 18,	10	90	$101\frac{1}{4}°$
" 19,	11	84	$99\frac{1}{2}$
" 20,	12	104	$100\frac{3}{4}$
" 21,	13	68	$100\frac{5}{8}$
" 22,	14	82	$100\frac{1}{2}$

CASE XXVI.

Phlegmon of the size of a Hen's Egg, cured in five days after being incised—emptied, and kept continually filled with Dry Clay.

John McC., a laborer, of intemperate habits, æt. 26 years, was admitted on the 8th of March, for a hard circumscribed phlegmonous swelling of the size of a hen's egg, on the apex of the posterior inferior cervical triangle of the left side. It had been a week in attaining to its present size, and as there were distinct evidences of fluid in its interior, a free incision was therefore made through it immediately after his admission. An ounce of sanious pus escaped, the cavity was at once filled with dry clay, and the patient experienced so much relief that he shortly afterwards fell asleep, and slept soundly through the balance of the day and the whole night following without any anodyne.

The dry earth dressing was reapplied every day subsequently, after the parts were well washed, until the 13th (five days after his admission) when the opening was completely filled and cicatrized, and the patient received his discharge, cured.

CASE XXVII.

Inguinal Abscess (strumous) opened under Local Anæsthesia—Dry Earth Dressing to the cavity, followed by Relief of Pain and Prompt Improvement in the Parts—Subsequent use of Tonics—Cure at end of fifty-five days.

Ellen D., æt. 9 years, admitted February 11th, 1869. At the time of her admission, this child had three distinct lymphatic enlargements on the right inguinal region, just below Poupart's ligament and close to the saphenous opening. Her friends could give us no explanation for the presence of these engorgements, nor was there any appreciable cause for them. She was allowed full diet, and permission to run about the wards, with the view of watching and getting a more thorough knowledge of the nature of her trouble.

Twenty-three days after her admission, March 9th, fluctuation was distinctly evident in all these three points, and after the integuments were made insensible by the ether spray, a free incision was made so as to give vent to all the pus. The operation did not appear to cause her much pain judging from the character of her cries, but whatever was the amount of pain caused by the incision, it was relieved by pouring some dry clay into it, for the child looked with evident relief and amazement at her groin after this was done. A thick layer of dry clay so applied was retained *in situ* by a bandage, and the patient was put to bed. The record two days after this, was "very little discharge this morning; granulations sprouting up and look quite healthy; dry clay renewed." This dressing was reapplied after washing every morning, without any noticeable change until the 25th, when the record states that there is some burrowing going on beneath the integuments towards the anterior superior spinous process. The earth was then packed in daily under the integument, and the effect of this was apparent. On the 28th it was noted that all ulcerative action had ceased, and that the parts were granulating in a satisfactory manner. The discharge pressed from under the integuments on the 25th, was decidedly offensive, whereas it was now perfectly healthy, both as to smell and appear-

ance. Dry earth dressings continued, and the patient was given six ounces of milk punch (one-fifth whisky) per diem. Solution of quinine ʒj, and the compound syrup of the phosphate ʒj, each thriee daily.

Under this she improved rapidly, was up and about the wards by the 10th of April, and eventually, on the 6th of May, she was discharged, the abscesses having been completely cicatrized for some days previous.

CASE XXVIII.

Strangulated Femoral Hernia of twenty-four hours' duration—Operation—External Wound closed by Harelip Suture—Dry Earth Dressing—Singular evidence of its power to control Decomposition, and prevent the spread of Erythematous Inflammation excited by Carbolic Acid.

Mary F., æt. 40 years, a slender and sickly-looking woman, strained herself very severely on the afternoon of the 9th of March in attempting to lift a tubful of wet clothes. She felt something give way at the time in her right groin, and on examination found a lump there which she had never noticed before. It was very sore to the touch, and shortly after its detection she became nauseated and faint; then vomiting set in, and continuing, a physician was called, who, recognizing the existence of a strangulated femoral hernia, attempted its reduction. In this he failed, and meeting with no better success the next day, and the symptoms becoming more alarming, she was sent to the hospital in the afternoon, about twenty-four hours after the strangulation was produced.

I saw her shortly after her admission, and after making but slight efforts at reduction while she was under the effects of ether, for I had some fears from the condition of skin, and the cessation of the vomiting, and her pulse, that the gut might have been gangrenous, I laid open the parts, and found a knuckle of intestine very tightly strangulated in the saphenous opening. There were two quite dark spots on it, but as these became lighter on relieving the stricture, it was decided to return the bowel without any further delay. There were no vessels re-

quiring attention, therefore after cleaning the wound of all coagula, I brought its tegumentary margin in close apposition, and retained them in position by harelip sutures, using for the purpose steel pins and gum elastic threads. Over this I applied about two heaping tablespoonfuls of dry earth. Ordered beef tea and whisky, and a hypodermic of atropia. The earth, she said, felt "cool and nice" to her.

At the end of twenty-four hours she had two movements from the bowels; said she had had some sleep, and was comfortable in every way. Had had some nausea and vomiting.

Pulse 100; temperature 98½°. On removing the earth found the uppermost pin was apparently binding the tissues too tightly. Removed it, but did not disturb the rest. There was no tumefaction about the wound. I ordered another hypodermic of atropia for that night; the same diet.

March 13th. Pulse this morning 120; temperature 102°. Had slept some. Bowels opened twice during yesterday. Some tympany, but less than in the evening before. Has some sharp stinging pain, with tenderness in the lower part of abdomen. No vomiting during last twenty-four hours. Removed all the pins; no union; margins evidently going to slough; some discharge; neutral to test paper. Ordered hypodermic of morphia, one-fourth grain, to be repeated, if necessary, to control peristaltic movement.

March 14th. Pulse 120; temperature 102°, last evening; this morning, pulse 120, very quick and jerking; temperature 104°. Had one-half grain of morphia yesterday by hypodermic injection. Has pain of a dull, heavy character in abdomen. Had some nausea last evening, shortly after getting the morphia. Tongue is red, especially along its margins. A slough has formed along the edges of the wound in a wavy shape, showing it to have been the result of strangulation from the harelip sutures. No tumefaction or discoloration of the rest of the wound. Noticed to-day, for the first time, a markedly erythematous blush on the labia, mons, and inside of thighs. In commenting on this, which was so singular in contrast with the condition of the parts which had been covered by the earth, I learnt for the first time that a strong solution of carbolic acid had been applied to those parts for the purpose of destroying the pediculi with

which they were covered at the time of the operation. The influence which the earth had had in preventing this irritation involving the wound was of a most marked kind; it had distinctly limited its spread in that direction. Dressed the parts with the earth. Ordered $\frac{1}{4}$ grain of morphia and 10 minims of ol. terebinth. every four hours; brandy and lime-water, also beef essence freely, in small quantities.

On the 15th sloughs showed well-defined lines of separation, but there was no perceptible odor from them, and neither their size or appearances seemed to have changed from what they were when first formed. This struck all who saw it as singularly in contrast with what we are in the habit of seeing where poultices have been used. It was quite evident this morning that the patient was dying from peritoneal inflammation. Her pulse was 140, temperature $103\frac{1}{4}°$, respiration 30. She was very restless; had been delirious in the night. Tongue dry.

She died on the evening of the 16th. No autopsy was allowed by her friends.

CASE XXIX.

A lacerated wound on the Dorsum of the Scapula in a patient with fracture of Thigh—Dressed with Dry Earth—Rapid recovery.

James O. D., a coal miner, æt. 44 years, was injured in the Beaver Meadow Mines, Carbon County, Pennsylvania, on the 10th of March, by a large mass of coal falling on him whilst at work, on his back. The injury consisted in a simple fracture of the left os femoris at the junction of its upper and middle third, and a lacerated and contused wound over the right shoulder. He was conveyed to Philadelphia (a distance of over sixty miles) the following day, and admitted into the Pennsylvania Hospital. There his fracture was reduced and dressed with Professor N. R. Smith's anterior splint, and the wound, a ragged and dirty one, about three square inches in area, was covered with dry clayey earth. The application of the earth was grateful to the patient, and in ten days' time, although he was compelled to bear some of his weight very constantly on the part, the wound had assumed all the

appearanees of a healthy granulating surfaee. Ten days later this nleer was noted to be nearly healed, and at the end of another period of ten days, it was firmly and eompletely eieatrized.

There was never any odor perceptible from this wound when sloughing (during the first week), as long as there was dry earth eovering it. On several oecasions during that time, from too long periods elapsing between the dressings, they became saturated, and the fetor was then very marked, being evidently intensified by the warmth maintained by the patient's pillow. He never eomplained of pain in it.

CASE XXX.

Seald (of second degree)—Dressed with Wet Earth after Rupturing Blisters—Perfect Relief of Pain—Cure in eight days.

A child æt. 9 years, with very fair eomplexion, had her faee badly sealded by the npsetting of a tea kettle, on the 12th of March. She was conveyed immediately afterwards to the hospital, and had the faee dressed. The seald had then resnlted in extensive vesieations, espeeially on the eheek and chin of the right side. The vesieles were opened, and a paste of elay and water was thoronghly applied all over the injured parts. Its applieation afforded very prompt relief to the ehild's sufferings, and she soon after went to sleep without the resort to any nareotie. This dressing was renewed every morning until the 20th (eight days after the aecident), when the patient was taken home eompletely reeovered.

CASE XXXI.

Fracture of both bones of Leg complicated by extensive contusion of soft parts—Burrowings of pus—Treated with Smith's Anterior Splint, Dry Earth, and free Incisions—No pain from Application of Earth—Thorough disinfection of discharge—Excellent cure in nine weeks.

John C., an Englishman, æt. 47 years, a machinist by trade, was brought to the hospital on the 2d of March, having had

his leg broken a short time previous on that day, by the falling of some bars of iron on the limb. The fracture was of both bones in their lower third, and was complicated by great bruising of the soft parts, without, however, any laceration of the integument. He had sustained some trifling bruises in other parts of the body. A Smith's anterior splint was applied, and the fractured bones readily adjusted and maintained in position by suspension. This apparatus was continued without anything going amiss for over a week. The limb then (on the 4th) began to swell, and became painful. The next day it had an erysipelatous blush extending some distance up, nearly to the knee.

On the 11th I surrounded this with dry powdered clay, and continued the suspension. The patient said the contact of the earth was very pleasant. He had however a bad night, and the next morning (the 12th) I detected fluctuation close to the inner malleolus, and made an incision there, and discharged some broken-down blood; the dressings were continued.

On the 13th, pulse 96, temperature 101°. On removing the dressings, found that there had been a considerable quantity of discharge from the opening since last dressing. What was in the earth had no odor about it, but that which escaped during the act of dressing was very offensive. The tumefaction and redness of the limb had evidently diminished within the last twenty-four hours. I continued the same dressings. From this to the 14th, his pulse ranged from 84 to 94, and temperature 100° to 101$\frac{1}{4}$°, and the limb discharged freely. Same dressings; no fetor.

On the 16th, there was an increase of pulse to 100, of normal force and volume, and temperature 100$\frac{1}{4}$°. The next day there was evidence of deep-seated burrowing. I then made a free incision on outer side of the calf, three inches long, and discharged fully one ounce of offensive pus. The fragments appeared to be maintained in excellent position by the splint.

March 20th. Pulse 92, temperature 101°. Has been sleeping well since opening was made, from the atropia given every night. Tumefaction of leg much diminished. Tested some of the discharge which percolated through the clay during the

night. It was very slightly alkaline; do not know how long it had been exposed to the air; continued dressing.

March 21st. Slept well last night without anodyne; leg doing very well. Pulse 88, temperature $100\frac{1}{4}°$. Did not sleep so well that night. Pulse 110, temperature $102\frac{1}{2}°$; limb painful. Found another depot of pus on outer side of leg four inches above the malleolus; opened it by free incision; an ounce and a half of tolerably healthy pus came from it. Ordered tincture ferri chlorid., gtt. xx t. d. Applied wet clay retained by waxed paper.

March 23d. Entirely free from pain since yesterday; dressing continued.

March 24th. Pulse 96, temperature $100\frac{3}{4}°$. Feels quite well this morning.

Two days later another collection formed on inside of ankle; this was opened. From that time the patient improved steadily, slept without any atropia; leg was always comfortable. The wet earth continued till the 27th, then the dry was used. After the 12th of April, the discharge was not sufficient to saturate the dressing after it had been on two days; no fetor or pain.

The splint was continued till the 15th (forty-fourth day); the union then seemed perfect, and nothing but the clay dressing was put on. The patient was kept in bed till the 26th, was then allowed to be up, and on the 4th of May, nine weeks after the accident, he went home cured.

CASE XXXII.

Staphyloma and complete disorganization of the Left Eye, from Chronic Ophthalmia and Entropion, of nine years' duration—Complete removal of Ball to save the right Eye from the effects of Sympathetic Ophthalmitis—Dry Earth applied to Socket immediately after the operation—No pain or annoyance at any time, but a pleasant cooling sensation, from its use—Stump completely formed, without any exuberant granulation, within two weeks—Improved Vision in Right Eye.

K. P., a single woman, æt. 21 years, was admitted on the 15th of March, for the purpose of having excised her left eyeball, which had been for a long time completely disorganized,

and was then threatening through sympathy the other eye. She gave the following history of her case.

She was a native of Ireland, and when about 12 years old was attacked by ophthalmia, which resulted in granular lids and entropion. For the latter trouble she was operated on by Sir William Wilde, at his hospital in Dublin, in 1866. The operation, according to the patient's account, consisted of only a partial ablation of the ciliary margin, and not by Sir William's modification of Saunders's operation. The patient suffered afterwards from inverted cilia, for which she was subjected, six months later, to another operation at Wills' Hospital, in this city.

There was then a well-marked staphyloma, and disorganizing inflammation in the ball continued after this latter operation had effectually removed all inverted cilia, as evidenced by continued pain and changes in appearance. The sight having begun to fail her in the other eye, she sought admission into the Pennsylvania Hospital, where an ophthalmoscopic examination revealed so clearly the beginning of sympathetic ophthalmitis in the right eye, that I suggested the immediate removal of the blind eye to save her from complete loss of vision. To this she willingly acceded, and I removed the ball by enucleation on the 17th, before the class, with the patient under the influence of ether. Prior to the administration of the ether, the patient had a hypodermic of $\frac{1}{40}$th of a grain of atropia, which had the effect of relieving her of the pain with which she had been almost constantly suffering. There was no hemorrhage following the operation; and after the margins of the conjunctivæ were all approximated, I filled the eye with finely sifted clay. This, she said, felt cool, and caused her *no* pain. She received another hypodermic of atropia ($\frac{1}{30}$th of a grain) at bedtime; with this she slept well through the night. The earth was washed out with a stream of tepid water on the following morning, and fresh reapplied as on the first day. Patient was very comfortable on the 19th. The report was that she slept well last night without any anodyne. No constitutional disturbance. Vision in right eye improving.

March 20th (third day after operation). No pain since operation. Patient up and about the ward. Earth reapplied.

The patient continued to do well under this dressing, and fourteen days after the ball was excised, the wound was completely healed, and I inserted an artificial eye. The right eye was then (April 1st), noted to be still improving. The porcelain one produced no irritation whatever; but I kept the patient in the ward over three weeks after it was introduced, not so much to watch its effect as to observe the condition of the right eye. This had steadily improved up to that time (April 26th), so that I was fully satisfied that the purpose of the operation, namely, the saving of the right eye, was sure of success. I, therefore, gave her discharge.

CASE XXXIII.

Necrosis with Secondary Fracture of Thigh—Offensive Discharge thoroughly Disinfected by Dry Powdered Earth—No Pain from Contact of the Powder.

On the 19th of March I admitted to my wards a very sickly-looking boy of seven years of age. He had about eight weeks previous received a blow on the right thigh whilst at school. From this he suffered so much that he was not able to attend school afterwards. When he had been confined to his bed from suffering with his limb about five weeks, his mother one morning attempted to lift him up, and then heard something in his thigh give a distinct snap. Two weeks of increased suffering after this resulted in an abscess discharging just above the knee. For this poultices were applied constantly, until he was brought to the hospital. Then it was determined for the first time that there was a fracture of the os femoris, at the junction of middle and lower thirds. On his admission dry powdered earth was applied, on account of the offensive character of the discharge; and after retaining it in contact with the parts by a Scultetus, the limb was suspended by a Smith anterior splint. The disinfection by the earth was complete, and the patient said its contact with the opening was "cooling," and gave him no pain whatever.

He was ordered full diet—quinine, gr. j, ter die, syrup. phosphat. comp., wine, milk, &c. This treatment was continued

steadily until the 19th of May, two calendar months; the earth being renewed each morning with the effect of keeping down all disagreeable odor.

On that day (May 19), I changed the apparatus, substituting extension by weight, and lateral support by sand-bags. The discharge had then very much diminished in quantity, and was of a thin ichorous character. His general condition was wonderfully improved in every way. The earth was still continued.

By the 1st of July there was firm union by an immense mass of callus all around the original seat of injury; there was still some thin discharge. Left off the extension, but continued the earth. An examination on the day of my leaving the ward showed a large sequestrum encased in the callus; the patient was then able to walk about the ward; his general condition was very good.

CASE XXXIV.

Varicose Ulcer of Leg—Hemorrhage—Monsel's Salt applied—Subsequent Dressing with Dry Earth—Rapid Improvement—Healing then delayed by the Patient being about without proper support—Ulcer finally Cured by Confinement in Bed for eight days with Earth-dressings.

Ann M., æt. 38, widowed, a cook by occupation, who had been suffering with varicose veins for a long time, bruised her leg early in January, just below the knee; the abrasion soon afterwards became ulcerated, and remaining in that condition, she was seized with a profuse hemorrhage from it on the 22d of March while she was engaged in removing a piece of cloth from it. This hemorrhage was checked after a time by a physician, who applied some yellow powder to it (probably Monsel's salts). After this hemorrhage was arrested the patient was sent to the hospital. There the dry clay was applied, and its application repeated every morning after washing the limb. There was no fetor from it, although considerable sloughing had ensued, probably from the effects of the styptic. By the end of six days the slough separated, leaving an ulcer $1\frac{3}{4} \times 1\frac{1}{2}$ inches, and there were two small ulcerated points to the out-

side below the large one. The patient directed to remain in bed. The earth was reapplied regularly, and was always cooling and pleasant in its effects. Nine days later all the ulcers had filled up nicely, and had begun to cicatrize. The earth-dressings continued. The cicatrization progressed, however, very slowly, for by the end of a month after the patient's admission the ulcers were still open, and on inquiry it was ascertained that she had been constantly walking about, despite the directions given that she should remain in bed. The effects of enforcing this direction were very apparent in the course of two days after, for the ulcers were then reduced very positively in size; and eight days later they were completely cicatrized, and the patient received her discharge.

CASE XXXV.

Gunshot wound of Thigh—Dressed with Earth—Wet for first eight days, afterwards with it dry—No pain—Wound healed, and patient walking with the limb on sixteenth day.

Mary A. B., a child of eleven years, was accidentally shot, on the morning of the 23d of March. She was standing up at the time, with the left limb somewhat in advance of the right. The bullet—that of a navy revolver—entered the left thigh, at its outer side, at a point six inches below the anterior superior spinous process of the left ilium, and on a line drawn vertically from that process. It passed obliquely downwards from this point, traversing the muscles on the back of the limb, and made its exit on the inside, at a point three inches lower down, and on a vertical plane considerably posterior to that of the point of entrance; from there it passed across the front of the right limb, making a groove of an inch long in the integuments covering the patella. She was brought to the hospital about two hours after the occurrence, in the state of marked shock. There was no bleeding from the wound, nor had there been, according to the statements of her friends who accompanied her. She was given an ounce of wine, and shortly afterwards a hypodermic of $\frac{1}{40}$th of a grain of sulphate of atropia.

Dry clay was applied in and around the track of the wound. She slept nearly the whole of the day and night after.

On the following morning she expressed herself as being very comfortable, and entirely free from the pain she had in the limb when she was brought to the institution. Her skin was, however, hot and dry, tongue furred, and the nurse stated that she had vomited on waking. She ate some breakfast afterwards, and retained it. Her pulse was (at $7\frac{1}{2}$ A.M.) 120; temperature, $103\frac{1}{4}°$. Her wounds looked very well; there was no tumefaction or redness about them.

Dry earth reapplied after washing off the previous dressing. Hypodermic of atropia, $\frac{1}{40}$th grain, repeated at bedtime.

March 25th. Report of another good night's rest. Tongue cleaning; pulse, 106; temperature, $102\frac{3}{4}°$; wounds looking very well. Wet earth was applied this morning, hoping it might favor the separation of slough, towards which the wounds did not, however, show any disposition. The atropia was to be administered, if required, on account of pain.

March 26th. The report of this (the third) morning was that she was in a good deal of pain during the day, and had to have the atropia at bedtime. This had the desired effect of relieving pain, and procuring sleep. Her appetite was poor, and she vomited her breakfast. Pulse, 100; temperature, $102\frac{1}{2}°$. Wet earth continued. Sloughs beginning to separate, but no tumefaction of lips or track of wound; none of the limb.

During next twenty-four hours she was entirely free from pain; appetite improved, and slept well.

On the morning of 27th (fourth day) pulse was 100; temperature, 101°. Same dressing. That night pain in both her limbs was such as to prevent her sleeping, even with the hypodermic of atropia. The points where the previous injections were made were noticed to be red, swollen, and very painful; and she stated they had been distressing her for two days. Pulse, on the morning of the 28th, was 104; temperature, $103\frac{1}{4}°$. Wet earth-dressings continued.

March 29th (sixth morning), pulse, 96; temperature, $102\frac{1}{2}°$; two small shreds of slough came from the wound this morning; the points on the arm where the hypodermics were applied,

much better; better appetite; digestive and urinary organs have been acting with regularity. Wet earth still continued.

By the 31st (the eighth morning) all the wounds were looking so perfectly clean and healthy, that the dry clay dressings were used. Pulse, 84; temperature, 100½°.

In the next four days the wounds were so well that the patient was allowed to get up and go about the ward, and the discharge was so trifling, even after she had been about for two days, as not to have dampened through in that time the layer of half an inch of clay which had been applied to the orifices of the track. Her power to walk was, of course, but limited at this time, yet she did move about, and it was a matter of surprise to all familiar with the damage which the muscles on the back of the thigh had sustained to see how rapidly she improved in the use of the limb.

On the 7th of April, the fourth day of her being up, and the sixteenth after injury, she walked into the amphitheatre, a distance of nearly one hundred feet from her bed, and back, without assistance or inconvenience.

By the 20th of April all the points were cicatrized, having healed up steadily without a single drawback, and the patient was well enough to be discharged, but she was not taken home by her friends for six days after this.

M. B., GUNSHOT WOUND OF THIGH.

Date.	No. of Days.	Pulse.	Temperature.
March 24,	1	120	103¼°
" 25,	2	106	102¾
" 26,	3	100	102½
" 27,	4	100	101
" 28,	5	104	103¼
" 29,	6	96	102½
" 30,	7	88	101
" 31,	8	84	100½

CASE XXXVI.

Ulcers on front of Ankles—One over line of long Saphenous Vein—Healed under Earth-dressing—Re-opened and Healed repeatedly until Obliteration of Vein was effected by an Operation—Frequent

Pain in Ulcer preceding Bleedings—History of Syphilis—No Pain on first contact of Earth—Nocturnal attacks of Pain—Pain on one occasion during the use of the Earth, which disappeared on use of Yeast Poultices.

H. B. E., æt. 25, was injured in both of his ankles by the falling of some bricks at a fire early in December, 1868. The injury was inflicted at night, and was thought to be but trifling at the time. He continued on his feet, with his boots thoroughly saturated with water, until the next morning. His feet had then become very painful and swollen, and on removing the boots he found the skin on the inner and dorsal surfaces of the feet abraded. He kept about for a week, but was then compelled to take to his bed. Sloughs formed; were separated by poulticing. The ulcers left were cicatrized under stimulating applications in the course of four weeks. Two weeks later an ulcer formed on either ankle, to the outside of the inner malleolus. These resisted all treatment for over two weeks. He then (March 23d) sought admission to the hospital. The ulcer over the left ankle was half an inch in diameter; that over the right one and a half inches. They were both discharging freely, and the seat of severe and constant pain.

They were both covered with dry powdered earth, retained by a bandage around the joint. This application, the patient said, relieved the pain as soon as it came in contact with the ulcers.

The next morning the patient said he had not had any return of the pain, and the ulcers looked a great deal better. Dressings continued.

In the course of six days of this treatment the ulcer on the left foot was entirely healed, and that on the right was very much diminished in size.

Everything progressed favorably in this way, although I often found the ulcer at my visit in the morning entirely bare of the earth.

By the 6th of April the ulcer was less than half an inch in diameter. It then took on irritation, and doubled its size in two days' time. I then learned of there being a syphilitic taint in the patient, and ordered potass. iod., gr. x, t. d. The earth now, as at first, relieved all pain when recently put on, but

towards night the patient experienced burning and throbbing in the ulcer.

By the 10th the ulcer had assumed a distinctly serpiginous form. Applied the earth wet. This gave the same relief the dry application had recently.

By the 15th the ulcer had become excessively sensitive. Dry clay was then resorted to without any change in the pain.

On the 21st he was walking about the ward on crutches (without permission), and fell down, striking the knee so as to make it bleed in a manner which occasioned him great alarm. This had the effect of relieving the pain. After this date I ceased to disturb the part any more than to add more earth to it every morning. The foot then always felt easy. Added iron and quinine to his other treatment.

May 6th. The ulcer entirely healed save a minute spot. Applied the clay.

May 9th. Ulcer entirely healed.

A portion of the cicatrix directly over the long saphenous vein gave way when the patient was up on his feet on May 11th, and as there was a distinct slough forming on the 12th I ordered an yeast poultice. With this continued for five days, the ulcer, which had become as large as ever, filled with healthy granulations. I then resorted to the dry earth (on the 17th). This gave him so much pain through the night that I returned to the poultices. Under these the ulcer was healed entirely by the 24th. The patient was then allowed to be up, but in the course of ten days a bleb formed, and then the ulcer returned as before. The patient now became convinced that there was no permanent cure for him until the vein was obliterated, and consented to my operating. This I did on the 9th of June by exposing and dividing the vein just above the ulcer, and then twisting both its ends. I closed this wound with stitch, gauze, and collodion, and applied the dry clay. Did not disturb this dressing for two days; found the ulcer then completely cicatrized. The wound was healed. Did not wash the parts; reapplied the earth.

Two days later patient complained of a burning pain in the wound; of none in the cicatrix of the ulcer. The wound then opened and discharged some coagula. Continued the dry clay,

and did not wash the parts for ten days; all was found healed. Nothing was then used but a spiral from toes to the knee.

July 4th. The wound opened again yesterday, and discharged a little sanious fluid. No trouble from the old ulcer.

Finally the wound became quickly healed after a cauterizing followed by zinc ointment for two days, and the patient was discharged on the 17th of July.

NOTE.—This was certainly not a satisfactory case of the earth-dressings, and yet it must be conceded that the patient's conduct, which prevented the earth very generally from being retained *in situ* any time, made it anything but a fair case to judge of its effects by.

CASE XXXVII.

Caries of Upper Jaw following Extraction of a Molar Tooth—Sedative influence of Earth demonstrated, after failure of Lead Water and Laudanum to allay pain—No pain from direct contact of the Earth with the diseased parts—Some pain at end of a week not relieved by Poulticing.

Catharine L., æt. 40, was admitted, on the 23d of March, for trouble in her left cheek, following the extraction of a molar tooth from the upper jaw ten weeks previously. An abscess in the gum, on its outer side, had followed very quickly after the operation, and was opened in the mouth. Shortly after this she had suffered constantly, but especially at night, with most distressing pain. She looked haggard, and the cheek was very much swollen, red, and very sensitive to the touch. Lead water and laudanum were applied for five days after her admission to the hospital. This treatment was without any relief to her sufferings.

On the 8th, after as thorough an examination as the patient would permit, I could not detect any fluctuation; there was, however, very great tumefaction, involving even the subcutaneous tissues. I then applied wet clay over the cheek, and covered it with waxed paper, which I retained in place by adhesive strips. This dressing, she said at the time, was "cooling and nice," and the next morning she said it afforded her considerable relief all of the previous day; that she had some

increase of pain at night, but not as severe as it had been. I repeated the dressing every morning, and had the same report as to its effect.

On the 11th there was some indistinct signs of pus. Made a deep incision, and gave vent to a few drops. Continued wet clay.

On the 14th, she reported that some pus had found its way, for the first time, through the socket from whence the tooth had been removed. Swelling and pain in cheek less. Continued the wet earth. On probing through the opening on the cheek, May 18th, I demonstrated extensive caries of the superior maxilla. I exposed the part by free incisions, and scraped away a considerable amount of carious bone. Left the wound gaping, and filled it with dry powdered clayey earth. This did not give rise to any pain, but made the part, as she said, feel easy. The cheek was dressed in this way steadily, with same effect, for eight days (till the 26th). The patient then told my clinical clerk, that after the clay had been in for some time after each morning's dressing, she experienced an occasional sharp pain in her cheek, but that this was, however, not at all violent in character. I then ordered poultices, to be renewed each morning. Their use was continued steadily for twenty days, without removing the pain of which she had complained on the 26th. The discharge had now become thin and ichorous.

On the 16th I resumed the application of dry clayey earth. Under it the wound in the cheek steadily contracted to a small fistulous point, from which there occasionally escaped a small piece of carious bone. The tumefaction of the cheek had, by July 4th, entirely subsided.

CASE XXXVIII.

Vesico-vaginal Fistula, of three years' standing; the result of a protracted Parturition, when Patient was but fifteen years old—Operation—Complete trimming of Edges, and their coaptation by four stitches—Vagina afterwards filled with Dry Clay—Stitches removed on seventh day—Operation perfectly successful.

On the 24th of March I admitted a young mulatto woman,

for a vesico-vaginal fistula, when she gave the following history of her case: She was unmarried, 18 years old, and lived in a little alley in the southern part of the city, where she assisted her mother in doing washing and ironing for her livelihood. She had been suffering with this fistula for nearly three years, it having been produeed by a protracted labor when she was but 15 years old, and during which she had no medical assistance. This history was confirmed by the patient's mother. The fistula was, at the time of her admission, big enough to receive the end of my index-finger, and was situated close to the os uteri. I had the patient put to bed, and one of Sims's catheters left in the urethra.

In this condition I kept the patient until the 9th of April. I then thoroughly pared the edges of the opening, and to do this I was obliged to embrace part of the anterior lip of the os, owing to its close proximity to the opening. The opening required four stitches to close it effectually; three of these I secured by shot, and one by twisting. After mopping out the vagina thoroughly, and inserting the catheter, I applied about two heaping tablespoonfuls of dry powdered clay well up against the os and wound. To prevent any peristaltic action from the lower bowels, I had a two-grain opium suppository introduced into the rectum.

At five o'clock that afternoon I ordered the patient, as she seemed nervous and restless, a hypodermic of sulphate of atropia ($\frac{1}{40}$th). The next morning the patient informed me that she was very comfortable, and had had a very good night's rest. A digital exploration satisfied me that the clay in the vagina was still dry; I did not therefore disturb it. The catheter when removed was found coated with considerable concretion. A clean one was inserted in its place. For the reason above stated I did not disturb the clay until the 12th; on the morning of that (the third day), I washed the vagina out very carefully by means of a Thudichum douche bottle. There were no signs of blood or pus in the washing, and a speculum examination showed everything satisfactory.

On the 14th washing was repeated, this time with a gum bulb syringe (Davidson), and the earth reapplied as before. On this morning there was scarcely any concretion on the

catheter. At the end of a week from the time of the operation (namely, on the 16th), the speculum examination after the washing showed, as on those made on the 12th and 14th, no irritation whatever about the wound, and as it seemed firmly united, I removed all the stitches. The three which had shot on them had not produced the least irritation, whereas that that was twisted had cut its way partly through the tissue it embraced. An exploration of the parts after the stitches were all removed showed the union to be firm and perfect. I, however, reapplied the dry clay, and kept the patient in bed with the catheter in the bladder. The patient's bowels had not then been opened since the operation. They were, however, acted on that evening, but not very freely, without any inconvenience or injury.

The clay introduced on the 16th was not disturbed until the 19th, and that applied on the 19th was left till the 21st. Again on the 24th and 27th. During all this time the patient was constantly wearing the catheter. Over two weeks having then elapsed without the slightest evidence of the existence of any opening, there could not be any doubt of the success of the operation, and of sufficient time having been allowed for the cicatrix to become strong enough to bear the distension of the bladder. I therefore on the 30th left out the catheter, but directed the urine to be drawn off three times in every twenty-four hours. This was done for three days. I then allowed the patient to be up and about, and to pass her urine per via nat. An examination on the 3d of May having showed everything perfect, I gave the patient her discharge.

CASE XXXIX.

Comminuted Fracture of both Bones of the Leg, complicated with Ecchymosis and Stuffing—Results from use of Dry and Wet Earth of no definite character—Death at end of twenty-two days—Pyæmic Abscess in Joints of Upper Extremities.

J. H., a sallow German, æt. 45 years, was admitted on the 25th of March for a fracture of his leg, produced by a cart passing over the limb. The fracture was a comminuted one,

involved both bones, and was complicated with considerable tearing of the soft parts, but without any opening of the skin. The tibia was broken about two inches above the ankle-joint, and comminuted. The fibula was severed higher up in an oblique direction. There was great distortion of the limb. The fractures were reduced, and the limb suspended by Smith's splint. This apparatus sustained the parts in good position, and the patient expressed himself as comfortable, although not free from pain.

March 26th. Had passed a bad night; some more pain around the ankle. Removed the dressing; found a large bleb near the internal malleolus; the limb somewhat swollen and discolored; put some dry clayey earth on the bleb, and the apparatus as before.

During the next three days the swelling and discoloration steadily increased, and invaded the limb up to the knee, but there were then no signs of suppuration about the seat of fracture. I then (April 1), applied wet clay all around the limb, and covering it with waxed paper, readjusted the splint as before.

April 2d. Swelling somewhat (but evidently) diminished. A line of angeioleucitis traceable up the inside of the thigh. Ordered tr. ferri chl. General condition not much influenced. No fur of tongue; no rigor. Pulse 80. Good diet.

April 4th. Made three free incisions through the integuments on outside of limb for drainage and relief of tension; discharge of considerable amount of grumous blood. Continued wet earth. Same treatment.

April 6th. Detected the evidences of sloughs beginning over malleoli. Wet clay has been renewed each morning.

By the 9th the slough had formed down to the bone on the outside, making a communication with seat of fracture. The whole limb was now very much reduced in size. On this morning I enveloped the limb in dry clay and waxed paper. Ordered an ounce of whisky every two hours in milk; beef essence. Tr. ferri chl., &c., as before.

The next day, April 10, the leg looked decidedly better; had been very comfortable till towards morning. The clay wet throughout; sloughs separating.

Good report on the 11th. Ulcers from sloughs and incisions looking very well.

On the morning of the 12th I was informed that he had had a decided chill the evening before. The ulcers did not, however, present any unhealthy appearances. Pulse 80, feeble. No exaltation of temperature.

April 13th. Pulse 84, feeble; temperature $96\frac{1}{4}°$. Has had two more chills since last note. Removed four small fragments of bone from the opening on outer malleolus. Dry clay continued. Same treatment in other respects.

April 14th. Pulse 94, soft, easily compressed; temperature 96°. Skin quite cool; slightly moist. Tongue red, but not dry. No appetite; bowels torpid; sweetish odor from breath and skin; had a slight chill at 9 P.M. yesterday; says the chill was followed by fever and sweat; slept pretty well; no change in treatment.

April 15th. Pulse 104, very feeble; temperature $97\frac{1}{2}°$. Complains of rheumatic pains in various parts.

April 16th. Had another chill. Left wrist considerably swollen, and very painful; both shoulder-joints so much affected that he cannot move them; very weak; tongue dry and fissured. Died that night at nine o'clock. An autopsy hastily made revealed pus in the shoulder and wrist-joints, specially in latter, of left side.

CASE XL.

Eczematous Excoriations of the Leg of frequent occurrence for fourteen years—Dressed for more than three weeks with Dry Earth, but without any benefit—Subsequently healed in a little over two weeks by Benzoated Oxide of Zinc ointment.

Mary O'M., æt. 52, was admitted on 25th of March, for eczematous excoriations of the left leg, with which she had been suffering off and on for about fourteen years. Her first attack came on after confinement, about that time, and was speedily relieved. A little more than a year after this, and following again her confinement, she had another attack, which also yielded promptly to treatment. The attack for which she had sought

admission to the hospital was of about six weeks' duration, and had been provoked by bathing the leg in hot water. The cracks in the skin were very characteristic; they were discharging a serous gummy fluid; there was no varicose enlargements of the leg, but the skin was very purpuracious. Dry earth was applied, and the patient allowed to go about the wards. The dressing renewed only every other day, but without any appearance of improvement in the condition of the part. She made no complaint about the application; on the contrary, she frequently assured me that it was "cooling and pleasant," and relieved the itching. Its continued use had the effect of making the epidermis accumulate in large scales, often an inch or an inch and a half in diameter. This, after two weeks' use of the earth, was to be noticed at each dressing. Becoming thoroughly satisfied that the earth was not benefiting the case, I substituted for it some benzoated oxide of zinc ointment on the 17th of March. This was renewed, as the earth had been, only every other day, but it effectually healed the part without confining the patient to her bed, for she was discharged, perfectly cured, on the 4th of May, just seventeen days after the zinc ointment was first applied.

CASE XLI.

Crushed Finger—Amputation—Acupressure—Earth-dressing—Secondary Hemorrhage on removal of pin at end of nine hours—No direct union—Suppuration—Complete Cicatrization by the twenty-sixth day.

Samuel G., æt. 28, had the middle finger of his left hand crushed at noon, on the 25th of March, by a large stone falling on it. He was afterwards admitted to the hospital, and Dr. Ritz amputated through the second joint, by Teale flaps. One pin was used to arrest hemorrhage. The flaps were, after being well cleansed, accurately approximated and retained by one silver suture, strips of gauze, and collodion; no other dressing was used. On my visit the next morning, the patient stated that he had had a good deal of pain in the stump, but that he got some sleep from the atropia given to him. I then undertook to remove the pin, as there was no pulsation perceptible

through it; it was then but nine hours since it was introduced. Hemorrhage followed, and I was obliged to reinsert it. I then covered up the stump without washing it with some dry earth. Its application was grateful to the patient.

The next morning (March 27th) I removed the pin, without any recurrence of the hemorrhage. It was evident then, however, that we were not to get direct union; the coagula between the flaps were in the way of such a result. The dressing of earth was after this renewed every morning; with this we had a healthy granulating surface produced by the 10th of April, fifteen days after the amputation. This was by the 16th of the month entirely cicatrized, save at one small point; and, by the 21st, stump was entirely closed. No dressing. Patient discharged on the 24th.

CASE XLII.

Compound Fracture of Forearm—The Wound communicating directly with the Seat of Fracture—Closed by Gauze and Collodion, and covered with Dry Earth—Healed without any Suppuration within five days.

On the morning of the 26th of March Ellen M., æt. 35, who was living out at service, fell down stairs and sustained a compound fracture of the forearm. Both bones were broken just above the wrist, and the wound, about three-fourths of an inch long, was on the ulnar side, and communicated directly with the bone there. The patient was immediately conveyed to the hospital, and her injuries were dressed in the following manner by my resident: The wound was thoroughly cleansed, and then closed by gauze and collodion. A strip of paper was then laid on a Bond splint, and on this was placed some earth, so as to cover the wound when the limb was laid on the splint. The fracture was then reduced, and secured in the splint.

On the following morning the patient said she was very comfortable. There was no tenderness about the joint, and as everything seemed to be doing well the dressing was not disturbed.

I obtained the same report from the patient on the following

morning. I, however, removed the bandage, and even the gauze; the wound seemed thoroughly closed. The earth was then reapplied, as at first, and the limb secured in the splint.

Three days later the wound was evidently thoroughly united; the union having been direct throughout, the earth was therefore dispensed with. The limb was continued in the splint for five weeks and four days, and the patient was discharged at the end of the six weeks with a perfect cure.

CASE XLIII.

Extensive Burns and Scalds in an Old Woman of Intemperate Habits—Dressed from first with Dry Earth—Positive relief of Pain—Disinfecting Power well shown—Death by Tetanus on twelfth day.

Mary B., æt. 50, an old-looking woman for her years, a fact explained by the accounts given by some of her neighbors, who brought her to the hospital, of her intemperate habits, was admitted on Easter Sunday morning, whilst I was in the ward, for a burn which she said was caused by the upsetting of a tea-kettle. She was in a state of maudlin drunkenness at the time of her admission, and from the position, namely, lying against the stove, in which she was discovered, by persons attracted to her room by her screams and the character of her injuries, it was evident that her history of the accident could not be relied on.

The right side of her neck, the back of her shoulder, a space on the chest a foot square, and the whole upper extremity of that side, and the hand and forearm of the left side, were involved by the injury. The integuments of the neck, shoulder, and of the left forearm and hand were extensively vesicated, and were probably partly injured by the upsetting of the kettle, but the tissues of the right forearm and hand were burned more deeply. On the dorsum and palm they were involved down to the muscles, and an eschar over the ulna was found extending to that bone its whole length from olecranon to styloid. The burn on the side of the chest was also in the form of an eschar (a burn of at least the fourth degree). The presumption was therefore strong that this poor woman had gone, whilst drunk, to the stove in her room, and in attempting to raise the

kettle had upset it, and falling over herself, had laid against the stove for some time in the position in which she was found. She was, at the time of her admission, screaming and lamenting in the most piteous manner, and as soon as she could be got to bed, I proceeded to dress her burns. This I did with dry earth, covering all the parts as thoroughly and as rapidly as possible with the powder, retaining it in place on the arms by a Scultetus, and on the other parts by rollers. The effect of the contact of the earth was evidently, from the poor creature's expressions, most acceptable to her, and although her condition was not such as to allow me to accept of her statements as to the *manner* in which she had been injured, no one could ignore their faithfulness as to the relief she got from this dressing.

She was then given a hypodermic of $\frac{1}{40}$th grain of sulphate of atropia. Prognosis was "unavoidably fatal." Ordered whisky and beef essence to be given *pro re natâ*.

On the following morning the dressing was renewed; it had become thoroughly saturated with the discharge, and was offensive. Found some new blebs filled with coagulated lymph; these had been the seat of a good deal of pain during the latter part of the day and night before. Pulse 120, temperature 102°. All fetor destroyed by fresh earth scattered over the old dressings. The patient on this morning, as at every subsequent occasion, expressed herself as greatly comforted by the dressing as it was being applied. Her pulse and temperature continued high. She never complained of the burning pain after the second dressing.

On the 8th of April, ten days after the receipt of the injury, she showed some signs of trismus. These developed themselves rapidly, and the patient expired on the morning of the 10th. The treatment for the tetanus consisted exclusively of hypodermics of atropia and morphia with free stimulation. The result was one which we had, with every reason, anticipated in all its details from the first.

CASE XLIV.

Epithelial Ulcer on Side of Nose originating three years ago—Size of an American cent—Three-quarters of an inch in diameter—But slight benefit at first from the Earth-dressings owing to complication of Lachrymal Abscess—A voluntary resort to it afterwards with the result of cicatrization in less than a month.

Mrs. E. F., æt. 40, residing at Moorestown, New Jersey, applied for admission to the Pennsylvania Hospital on the 29th of March on account of an epithelial ulcer. The ulcer was the size of the present one cent coin, Amerieau currency (three-quarters of an inch in diameter). It was situated on the side of the nose, close to and just below the inner canthus. It had originated there in a fester, as she termed it, about three years ago. For it she had used by advice some sulphate of zine and gum acaeia. This healed the lower portion, but that above spread steadily in spite of the application, until it has attained its present size. She says it is still increasing. It has produced some eversion of the canthus and eonsequent epiphora. She has had occasionally sharp pains like that of the prieking of needles in it. The diseharge from it has never been offensive. There is no history of either phthisis or eancer in her family. A small mass of wet clay was applied and retained in place by a portion of waxed paper and strip of adhesive plaster immediately after her admission on that day.

At the end of the second day there was clearly to be seen a band of cicatricial tissue forming across the ulcer. The dry earth was then applied, and everything was doing well until the 7th of April, nine days after the treatment was eommeneed, when some conjunctivitis showed itself (for the first time), and the ulcer became painful and began to spread again. In a few days it was evident that the lachrymo-nasal duct was obstructed. The suppuration in it burst through the ulcer at the inner margin. This latter event happened on the 15th. Dry earth had been constantly applied all this time, and its application always allayed, for a short time at least, the pain. I then, on the 16th, directed the patient to reapply the earth as often as it became saturated. This, she said the next morning, had kept her free from pain, and the sore was evidently look-

ing better. The patient, however, asked for her discharge, which was of course given to her. On inquiry of others afterwards I ascertained the fact that she had been frequently seen by parties (members of the profession) visiting the hospital during the forming of the lachrymal abscess, and comments were made by them of such a character with regard to the dry earth treatment, in her presence, as to dishearten her from its further continuance; and that was the real cause of her leaving. Of this fact I made a memorandum at the time. My surprise was, therefore, not a little on being informed by my resident, on the 10th of the following month (May), that this woman had reported herself at the hospital as having been eventually cured of her ulcer by the dry earth. She had gone home disheartened; but, after taking advice and using some salves with the result of aggravating the ulcer, she took some earth from her own garden, and, drying it, applied it very constantly, with the effect of healing up the ulcer in less than a month's time after she had left the hospital.

September 15th, 1869. A. P., from Moorestown, N. J., called at my office to-day to consult me about her case. The ulcer on the side of the nose has remained firmly cicatrized up to the margins of the lids. At the margin of the punctum of the upper lid there is only a minute point of exuberant granulation; the rest of this lid is free from disease. There is an erosion on the lower lid three-eighths of an inch long, and from this margin a triangular-shaped ulcer extends in the orbit to the depth of three-fourths of an inch. I had great difficulty in finding on its uneven surface the orifice of the nasal duct. I found it just on the nasal margin of the ulcer, and about one-eighth of an inch from its anterior extremity. Into it I passed a silver nasal canula, and then packed the ulcer with dry, yellow clay, without any precaution against the earth getting into the orifice of the canula.

December, 1871. I have not had any subsequent news of this case.

CASE XLV.

Varicose Ulcers of Leg of over one year's duration treated by Dry Earth Dressings—Renewed at long intervals of time—Much benefited—Subsequent Development of other Ulcers through inattention—These likewise healed by Earth-dressings.

Mary R., a cook, aged 42, was admitted on the 30th of March, for varicose ulcers on both legs. She had been suffering with them for over a year. The veins of both legs were very much enlarged. The ulcers were situated just above the inner malleoli. That on the right leg measured an inch and a half by three-quarters, and that on the left two and a half inches in length by one inch wide.

Dry earth was applied to these ulcers and retained by well-applied rollers; the application was "cooling and pleasant." The patient was allowed to go about the house. The dressings were not changed for a whole week, when the discharge having then come through the bandages they were removed, and the ulcers were washed. There was then an evident improvement in the appearance of the ulcers; they looked decidedly healthier. Dressings renewed, and left on till the 12th of April. Ulcers were then found not only clean and healthy but diminished in size. Left measured $2\frac{1}{4} \times \frac{7}{8}$; the right $1\frac{3}{8} \times \frac{5}{8}$. Dry clay renewed.

April 17th. Patient had continued to improve up to this date, but this morning there were two new points of irritation noticeable on the right leg immediately above the seat of the original ulcer. The patient was reported as not having worn her bandage very well; had got it very frequently disarranged. The granulations covering the ulcers of both legs were then noted as exuberant; they were above the level of the adjacent parts. Did not cauterize them, but resorted to pressure, after covering them with the clay, by means of broad strips of adhesive plaster. Directed that the roller should be secured by stitching.

This treatment was continued with improvement of condition until the beginning of May. Some new points of ulceration then showed themselves, and when my attention was called to them on the 11th, they were in such a sloughing condition that

I ordered the patient to bed, and directed the application of yeast poultices to hasten the separation of the sloughs. These poultices were continued for eight days, when I found the ulcers so well cleaned out that I ordered the renewal of the earth-dressings to be applied with care, and that the patient should be made more careful about keeping her dressings on. After this these ulcers all healed up in the course of twelve days, from the time of the discontinuance of the poultices, and she was discharged cured on the 3d of June.

CASE XLVI.

Extensive Contused Wounds of Head, necessitating on second day a free Incision for the escape of Grumous Blood—Wounds constantly Dressed with Dry Clay—No Pain or Annoyance from its use—Profuse Suppuration from beneath Scalp—Patient discharged cured after a sojourn of five weeks and four days, with wounds completely cicatrized.

P. D., an intemperate hostler, from Ireland, æt. 38 years, was admitted on the evening of the 30th of March, for extensive and severe contusions about the head, supposed to be the result of foul play, but concerning which he could not give any very clear account. There was some hemorrhage from the right ear, but none from the nose or mouth. Nothing abnormal in pulse or temperature. After his admission he had four or five distinct convulsions.

On the following morning the amount of ecchymosis and tumefaction about the forehead was such as to induce me to make a free incision two inches long through the integuments, and turn out the broken-down blood. This wound I dressed with dry clay, which relieved the pain immediately; continued the use of the dressing daily. The suppuration from the wound became very profuse.

On the morning of the 7th of April, the tissues around both eyelids were noticed to have suddenly become ecchymosed, and on opening the lids both ocular conjunctivæ were found much infiltrated with blood. The patient had not had, up to the 12th of April, any return of the convulsions. The amount

of pus discharged from the opening on the forehead, was up to that time estimated at about four ounces per diem. Dry earth dressings continued. Never any pain or annoyance from them.

April 12th. The ocular effusion slowly diminishing, about two ounces of creamy pus discharged from the wound; dry earth dressings continued.

April 19th. Opening diminished; discharge much less; no burrowing.

On the 25th of April this patient had another convulsion, and from the accounts of those who saw it, it was evidently epileptic. The wound in the forehead was then nearly healed.

By the 8th of May it was firmly united, and the patient was discharged cured.

CASE XLVII.

Phlegmonous Inflammation of Deep Tissue of Hand and Forearm following a dog bite, which had been Cauterized, Blistered, and Poulticed—Treated after the fourth day with Wet Clay—Decided relief of suffering—Cure (after the evacuation of three distinct abscesses) in thirty-three days.

Maggie B., a domestic, æt. 21, was admitted on the 30th of March on account of phlegmonous inflammation of the hand and forearm following the bite of a dog, inflicted on the evening of the 26th of the month. She stated that the dog had bitten her in consequence of her tormenting him whilst he was eating, and that he was not a vicious dog, and had never before shown any disposition to bite. There was evidently no reason to suspect the dog of being rabid. The physician of the family with whom she lived was sent for immediately after the infliction of the injury. He cauterized the wound, which was a lacerated one on the thumb, and on the following day he ordered a flyblister over the wrist, and after that a flaxseed poultice to cover the hand and forearm, which were then very much reddened and swollen. When she came to the hospital on the 30th, she was still using the poultices. She was in great suffering, and the parts presented all the appearances of phleg-

monous inflammation of the deep tissues, but no point of fluctuation could be detected. Her tongue was furred, and she was feverish. Immediately after her admission wet clay was applied over the hand and forearm, and over it waxed tissue paper to keep it moist. This, she said, gave her great relief, and she was comfortable until evening. Then she began to have pain, and she was given twenty-five drops of Battley's sedative. After this she was entirely relieved of pain and slept all night, a thing she had not done before since she was bitten, even after taking opium.

During the next twenty-four hours she experienced still less pain. Hand and forearm much less swollen. Tongue still furred. Appetite poor. Bowels free. Continued wet clay. Got two drachms officinal solution of morphia at bedtime. Slept well. Continued this treatment.

On the 6th, swelling much reduced. Detected pointing on ulnar side just above the styloid process; a deep incision there towards the flexor carpi ulnaris gave vent to a large collection (probably, at a fair estimate, an ounce and a half) of fetid pus. The odor from it was destroyed by dry clay thrown on it. The hand was still considerably swollen, and especially in the vicinity of the thumb. Ordered wet clay to be continued, and twenty drops of tr. ferri chlor. to be taken thrice daily. Full diet. On dressing her myself on the 9th I discovered that the pus had found its way through the skin between the thumb and forefinger, and collected under the epithelial layer there. Removed the separated epithelium, but did not consider it necessary to enlarge the opening in the derm. Continued the wet clay dressing. Pus from this and the opening above the wrist abundant, and its odor always perceptible through the dressings in the latter part of the day. In consequence of this fact, ordered on the 18th dry clay to be substituted, with the result of effectually preventing any odor.

On the 19th detected another depot of matter above the annular ligament. This I opened and reapplied the wet clay to favor its discharge. Continued this wet dressing until 23d, then resorted to the dry clay, and at the end of ten days' use of it all the openings were cicatrized and the limb was cured.

Patient then (May 3d) discharged.

CASE XLVIII.

An Offensive Indolent Ulcer of thirteen years' standing benefited by Dry Clay Dressings—Fetor diminishing and finally disappearing under the Earth—Amputation of the Limb below the Knee—Failure of Ligatures and Torsion owing to Disease of Vessels—Hemorrhage controlled by Acupressure—Marked Fatty Degeneration of Muscles—Alarming and persistent Dyspnœa and recurring Syncope following Operation—Death evidently from Heart Clot on thirteenth day, shortly after washing the Stump for the first time—Remarkable Heart Clot and amount of Direct Union revealed by Autopsy.

Abigail B., a colored woman, æt. 56 years, but much older looking, who had been earning her living at the washtub, obtained admission to the hospital on the 1st day of April for the purpose of having her leg amputated on account of ulcer of over thirteen years' duration. She stated that she had had it healed several times during that period, but that it always broke out as soon as ever she got to work. The ulcer when first seen by me (on the day of her admission) was very offensive, with hardened and elevated edges, and a remarkably smooth and glazed surface. The integuments were darkened and scaly for a distance of over two inches all around the margins of the ulcer. The ulcer itself was located on the right leg just above the internal malleolus, and measured $3\frac{5}{8} \times 3\frac{1}{2}$ inches, and its surface was at least one-quarter inch below that of the surrounding parts.

Dry earth (clay) dressings were directed to be made to the limb in the manner heretofore used in the wards, and the patient was to keep her bed and have the ordinary house diet.

Twelve days of this treatment—the dressings having been removed and renewed each day after washing the limb—had the effect of reducing the size of the ulcer to $3\frac{3}{8} \times 3$ inches. Its surface was still smooth, and the discharge from it quite offensive. The odor was, however, always destroyed by the coverings of clay, and never was perceptible between the times of dressing unless the earth had become saturated and allowed some of the discharge to percolate through it. The amount of clay over the ulcer was never over one-half inch deep. By the 27th the ulcer had become reduced $2\frac{7}{8} \times 2\frac{3}{4}$ inches and had

some granulations over its surface; they were, however, very pale. Same treatment.

As during the next twelve days there were no evidences of improvement in any respect, I thought it advisable to allow the patient to get up, and to be wheeled out on a chair into the yard. The effect of this, in two days' time, was to increase the ulcer to $3 \times 2\frac{1}{2}$ inches, and the patient was so disheartened that she determined to have the limb amputated without further delay. This was accordingly done on the 13th day of May, with the patient under the influence of ether. The recognized existence of atheroma, and a fatty heart, made it necessary to administer the anæsthetic sparingly, and with great caution. The form of amputation adopted was that of double flaps at the middle of the leg; the anterior made from without in, and the posterior by transfixion.

More blood was lost than usual by attempts having been made to secure the vessels by torsion and ligatures; for both of these failed, in consequence of the diseased state of all the vessels; by the one they were broken short off, and by the other they were completely cut through, so that I had eventually to resort to acupressure, and used three pins for the main trunks, and serres-fines for the small ones. The surface of the stump was then covered with dry clay, and the patient put to bed to await thorough reaction before completing the dressing. A careful dissection of the part removed revealed a most remarkably complete fatty degeneration of all the muscles, thickening to the extent of nearly half an inch of the periosteum immediately in the neighborhood of the ulcer, with great thinning of the bone, but no evidences of caries or necrosis. The patient showed quite alarming symptoms of shock and depression for some hours after the operation, having had constant dyspnœa, and frequently recurring, but imperfectly developed attacks of syncope, in spite of free stimulation. At the end of five hours, I however ventured to dress the stump, using silver sutures, and gauze and collodion, for the purpose of effecting accurate coaptation all around, save at the two angles, which I left free for about one inch for drainage. The stump was then placed on a bed of dry clay, in a box extemporized of binders' board for the purpose, and completely covered in by some more

clay poured over it. This dressing, made with the greatest care and gentleness, exhausted the patient very much. She suffered all the following night with dyspnœa, and constant nausea and vomiting. She rejected all nourishment and stimulants. The following morning her pulse was 116, very feeble; temperature 104¼°. The stump was not disturbed. The three pins were removed from the main trunks forty-four and a half hours after they were introduced; no hemorrhage at the time. The dressing, which had been on during that time, contained about an ounce of fluid, as well as we could estimate by the bulk of wet clay in the box. This wet portion was taken off, and replaced by some dry. To do this the stump was simply raised up out of the box, and a spatula gently used to scrape it off. No water was used.

The patient's condition was anything but satisfactory. Her stomach was still excessively irritable, and she had to be propped up in bed on account of the dyspnœa. Pulse 116, fair volume; temperature 103°.

On the 15th (third day after the operation), somewhat better; less nausea during the past night and this morning; tongue furred; has taken and retained a tablespoonful of effervescing draught every two hours during the last twenty-four hours; pulse 108; temperature 102°; stump somewhat stuffed, and tender along the track of the internal saphenous; the margins looking very well indeed; no signs of sloughing. Removed the stitch nearest the inner angle, to give a freer exit to any discharge; the other stitches with gauze left in place; stump replaced in the box of clay. No odor from the wound; no pain since the operation, save when the stump is lifted out of the box, or is pressed along its inner side.

On the 16th (fourth day after the operation), pulse 100; temperature, 101¾°; nausea much less; takes nourishment; slept some (but not much) during the night; still a great deal of dyspnœa. As her being propped up in bed seemed to have the effect of thrusting stump down into the box, I resorted to the expedient of suspending the box with the limb in it.

The next morning (that of the 17th of May), both her pulse and temperature showed signs of positive improvement; the former was 88, the latter 100½°. Her stomach was still irri-

table, and tongue was coated with a whitish fur. The dressing renewed in the same way as heretofore, without washing, and the stump suspended. Neither the stitches nor the gauze were yet disturbed.

The amount of discharge from the stump, in the next twenty-four hours, was estimated at about two ounces, chiefly from the inner angle. There was evidently then some burrowing going on; the discharge could be made to come out by pressure along the track of the internal saphenous vein. Nothing of importance noted from this time till the 20th (the eighth day after the operation), when the stitches were removed, but gauze was left as it was, still firm in place. The dressings were continued regularly each day without washing, and with as little annoyance to the patient as possible. Her dyspnœa and nausea still continued, although decidedly less severe. The gauze remained firm in place up to the 25th, when I was tempted to remove it, and give the stump a good washing, from sheer curiosity to see how it was doing. I found that union had taken place all along the margins of the flaps, save at the two angles which I had left open, and at a minute point opposite the end of the tibia, from which I could squeeze a few drops of pus. (The patient lamented a good deal whilst I was doing this, although she did not tell me, in answer to my question, that it really caused her pain.) After the washing, I reapplied the gauze, covered the stump up, and suspended it as heretofore. The whole occupied some twenty minutes of time; but after it was completed, I was not a little alarmed at the effect which it had had on the patient. She was more than ordinarily prostrated. Her pulse, in a short time after, even under free stimulation, was 130, an increase of 24 over that of the same time of the day previous, and the temperature 101°. I left the patient at this time to attend to my private practice. I felt, however, so much concern, that I returned to the hospital at noon to see how she was, and found that she had died about two hours after the dressing of her stump, apparently from heart-clot, formed at that time.

An autopsy, twenty-four hours after death, revealed the lungs healthy, with some hypostatic congestion. The heart was pale, and so soft that the finger would break through its

walls at any point on slight pressure. There was a firm and colorless clot in the right side, extending into the pulmonary artery, and quite a soft clot in the left ventricle. There was no valvular disease, and no more than a normal amount of fluid in the pericardium. The kidneys were very light-colored and anæmic; the liver the same. The muscular structure of the bloodvessels throughout the body showed everywhere evidences of fatty degeneration and atheroma.

A cast of the stump was taken after the autopsy, so as to show as well as was possible the extent of the union. For this purpose a block was placed under the knee, so that the posterior flap could not touch the table, but would stretch on the cicatrix to the utmost extent, and gape open all the points which were not united. From this cast I have had two photographic views, and they give a very fair idea of the thoroughness of the union; and besides, I append an account of a careful dissection made of the stump by Dr. Harrison Allen, of the University.

The case of this old colored woman was one full of interest to me. The long standing of the ulcer (over thirteen years); the fact that it had improved to an unexpected extent (its area having been considerably contracted), whilst the earth was used on it as a topical application; the existence of fatty heart recognized before the operation, and the imminent danger which we ran in using an anæsthetic (ether); the most complete fatty degeneration of all the structures of the limb removed; the varicose condition of the veins, and the ossified condition of the artery in the stump, made it in every respect a most interesting case to study, and its unfortunate termination gave us the opportunity of completing the record in such a way as to render it one of the most instructive cases possible.

The remarkable amount of cicatrization which had been accomplished in the thirteen days which elapsed from the date of the operation to that of her death, and that too in tissues which were so singularly affected by fatty degeneration, was specially interesting in connection with the dressings of dry earth. All authorities in pathology have heretofore taught that we have never a right to expect direct union in tissues so affected, and that we must always look for sloughing and

putrefaction after amputation under such circumstances. For such we have not long since had a most positive demonstration of the cause in a series of experiments by Mr. A. Stuart,* of Petersburg, in which he studied the effects of inflammation.

Dr. Edward L. Ormerod, in his admirable essay on the "Pathology of Fatty Degeneration," in the fourth volume of St. Bartholomew's Hospital Reports for 1868, p. 531, referring to these experiments in connection with the results of his own observation on fatty degeneration of the heart, says: "By the application of nitrate of silver to the muscles of frogs changes were induced in them identical with those which we have just traced in the heart. The parts directly exposed to the chemical action of the caustic swelled or shrunk up and their texture was destroyed; but those a little further off underwent a regular series of changes of inflammation, in fact, which Mr. Stuart describes with great minuteness thus briefly, first, the muscles became pale and more transparent than natural; then the sarcous elements seemed to break up and arrange themselves in longitudinal rows; then these dots became larger, though still remaining sarcous elements. These changes occupied two or three weeks, the process thus far being disintegration rather than degeneration, no fat having as yet appeared in the altered tissue. Then the last stage set in, namely, the conversion of the albuminous substance into fatty matter. Inflammation, anæmia, cachexia, want of nutrition, and all the other causes to which fatty degeneration of the heart has been ascribed," as Dr. Ormerod further remarks, "have this much in common, that they disorganize the fibre and prepare it for ulterior changes."

In such cases then as this poor woman's the structures are already in that stage of disorganization, that the inflammation which we are to look for after an amputation through them, must be speedily followed by their more or less complete destruction. And yet in her case there was not only an absence of all signs of inflammation in the flaps of the stump, as we have seen in other wounds treated with dry earth, but the same extraordinary disposition towards union of the divided tissues, as is shown in the detailed account by Dr. Harrison Allen of the dissection of the parts after death in her case.

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* Schultz, Arch. für Microscop. Anat., 1 s., 415.

To give a more thorough demonstration of the extent of union in this instance than a photograph could possibly do, I resorted to the expedient of having a plaster cast taken of the stump when hanging over a block, so that the cicatrix would be stretched as much as possible, and the plaster in taking the mould could be run into any cavities or defects along the line, and from such a cast I could have photographs taken. A careful examination of these pictures will not only show that there was never any loss of substance along the epithelial margin of the original incisions which created the flaps, but that union had taken place between the skin proper and subcutaneous tissue of both flaps all around where coaptation had been secured by the primary dressing. The broad cicatrix shown by these pictures was well covered with epithelium, and never discharged any matter save at one point about its centre, which point communicated with the end of the tibia. The disposition to the formation of epithelium by extension from the margin, which has been so uniformly noted in all previous instances, was as fully marked in this as in any others.

The external appearances were as follows:

"The flaps were united across the end of stump, the angle being alone open. The posterior flap projected a little beyond the line of the anterior at the inner angle. The tibia had made no injurious pressure upon the anterior flap.

"Upon exposing the interior of the stump by a vertical section at the median line, the free edge of the bulky posterior flap was seen to be well united to the anterior flap its entire depth, namely, about one-third of an inch. The space between this line of union and the end of the bones was lined with pus-stained granulations. Extending upwards from this cavity, and continuous with it, was a broad, shallow burrowing, defined in the abundant subcutaneous fat. It extended along the line of the long saphenous vein as far as the upper border of the patella. It was broader below than above, where at the point of termination it was less than an inch in width. There was no appearance of distinct pouches in the stump. No pus whatever was found in or about the parts. Such as had been present during life had been pressed out or otherwise removed.

"The tibia was bared of periosteum one inch anteriorly, one

Woodburytype. *A. P. R. P. Co., Phila.*

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Showing the amount of union in thirteen days.

line posteriorly. A well-defined border of granulations extended between these points.

"The fibula exhibited a minute necrosed area, confined to portions touched by the saw. There was no burrowing at any point beyond the one already mentioned.

"The line of union did not extend up to the extremities of the bones. A well-applied dressing to the stump may have brought the ununited portions in contact.

HARRISON ALLEN."

June 9th, 1869.

CASE XLIX.

Pirigoff Amputation for Injury—Acupressure—Subsequent Stuffing and Sloughing in Leg from Hemorrhage, probably from Wound of Posterior Tibial—Prolonged Convalescence—Efficiency of the Earth as a Disinfectant thoroughly proven—No Suffering from its use.

Christian B., æt. 48, living in New Jersey, had his foot mangled in a saw-mill on the morning of the 1st of April. He was immediately conveyed to the hospital, and within two hours of the occurrence I performed a Pirigoff, as the patient was then in a state of good reaction; he had received a hypodermic of atropia and an ounce of whisky some twenty minutes before I operated. The saw had passed across the foot through the metatarsus, severing it almost in two. The wound was so high up on the foot that I had but scant material for the anterior flap. I, therefore, to secure good coaptation, divided the tendo Achillis subcutaneously, as for club-foot. Three acupressure pins were used, one on the anterior tibial, and two on the plantar flap, one serre-fine was also used on the latter. After reaction from the ether, the surfaces were first washed off with tepid water, having some clay suspended in it. This the patient said was pleasanter than the plain tepid water with which I finally drenched the parts before closing them. I then closed the wound and coaptated its margins by harelip sutures, on account of difficulty from retraction, and used but one strip of gauze. This was done two hours after the operation. There was then no bleeding whatever. The stump was after this covered with powdered earth (subsoil), and the patient put

to bed. That night he slept well, and said he was comfortable at my visit the next morning. His pulse was, however, 108, quick and jerking, temperature 103°. He had some burning pain back of the heel. No pulsation transmitted through any of the pins. I, therefore, after uncovering the stump, removed them all, just nineteen hours after their insertion. The margins of wound were looking well. Watched some time, and finding no oozing and stuffing, I reapplied the earth. This was grateful to the patient, and he was asleep within ten minutes after the dressing was completed.

On the next morning (the second after the operation), I found him not so strong; his pulse 120, temperature 103½°, temperature of stump when covered by the earth, 102½°. Complained of nausea after eating his breakfast this morning; was quite free of pain, and had slept well, from the atropia which he got at bedtime. There had been considerable oozing from the inner angle of the wound, more than sufficient to saturate the dressings; there was marked tumefaction there and up the back of the tibia, and as the incision for the anterior flap had, during the operation, to be carried well up to the line of the posterior tibia, in order to get within the laceration, I felt this morning confident that I must have pricked that artery with the point of my scalpel, and hence the evidence we had of hemorrhage, from the pulse, for the last two days. Continued the same dressing; no complaints of it.

The next morning my suspicions were more than confirmed, for it was apparent that the tissues were going to slough at the point referred to. Temperature 103°, pulse 110. Continued the earth as before; it was comfortable to the patient.

By the 6th the slough had formed, and as the os calcis was bared, I removed it that morning. There was some union on the outer side of the stump. By removing the fragment of the os calcis, I converted the stump into one resembling a Syme.

On the 7th, pulse was 120, feeble; temperature 102½°. Tongue furred; leg swollen, with fluctuation on inner side of tibia three inches above the ankle. Made two free incisions, and gave vent to a large quantity of grumous matter. I then put the leg in a fracture-box, and covered it completely with earth.

Ordered quin. sulph., gr ij, t. d.; whisky; full diet. Continued this treatment, and on the 9th his pulse was 100, temperature 101½°. General condition much better. The inner half of the heel flap had then sloughed away; the sloughing was singularly confined to this portion.

On the 10th, pulse 108, temperature 102¼°. Had slept well without any anodyne. Another collection of pus detected this morning deeply seated on outer side of leg, posterior to the fibula, and as high up as that on the inner side of tibia. Opened it freely, and found it to contain sloughs of cellular tissue. The discharge very offensive; the odor disappeared when some earth was thrown on it. The discharge from parts when the earth had just been removed perfectly neutral to test-papers. Ordered, to hasten separation of slough in the leg, an yeast poultice, to be covered by waxed paper, and the limb, after being put in the fracture-box, to be buried in dry powdered earth for the purpose of securing disinfection.

These had the desired effects. The discharge on removing the poultice was decidedly acid in its reaction. Pulse 96, temperature 100¼°. Continued the poultice and dressing same as of the 10th. Suppuration became very profuse, amounting at the dressing on the 13th to nearly half a pint from all the openings. Pulse was then 100, temperature 101¾°. Discontinued the poultices, as sloughs seemed to be all away. Used the dry clayey earth alone.

April 14th. Pulse 96, temperature 100½°. The quantity of discharge, by estimation, very much less. Earth not wet through; no pain. Ordered tinc. ferri chlor., gtt. xx, t. d., with the quinine as heretofore. Ulcerated surface from slough at the heel beginning to cicatrize. To favor this, I applied a long strip of adhesive plaster on the back of the leg, and extending it beyond the point of the heel, I attached the weight of half a brick to it after the earth-dressings were made as heretofore. This proved a source of annoyance to the patient, and I abandoned its use and brought the edges together by two stitches of silver wire.

During the next five days manifested a good deal of constitutional disturbance of a pyæmic character, his pulse ranging from 100 to 114, and temperature 101° or 102°. Was sweating

profusely. Test-paper applied to the skin showed a very acid reaction, and the discharge, even where the earth had been, was inclined to be acid. Then came some improvement in all these respects.

On the 22d the notes state that he has a brighter expression; tongue clearing off; did not sweat so freely last night; not more than half an ounce of discharge from all the openings. Dressings and treatment continued, with occasional drawbacks from penning up of matter by too rapid cicatrization of the openings. This patient improved steadily, was up and about in a wheel-chair on the 13th of May, and by the 1st of June all parts were nearly completely closed. Patient was eventually discharged, cured, on the 19th of June. The dry clay had been steadily used, save when burrowing was going on, then either a wet cloth covered with waxed paper or a poultice was used to hasten the process more than we found the earth would do. This patient suffered frequently and very much as the abscesses were forming, but never any from the contact of the clay. On the contrary his expression was uniform that it felt good in the parts to which it was applied.

C. B.'S AMPUTATION.

Date.	No. of Days.	Pulse.	Temperature.
April 2,	1	108	103°
" 3,	2	120	103½
" 6,	5	110	103
" 7,	6	120	102½
" 8,	7	110	101½
" 9,	8	100	101½
" 10,	9	108	102¾
" 11,	10	96	100¼
" 12,	11	104	101¼
" 13,	12	100	101¾
" 14,	13	96	100½
" 15,	14	100	102½
" 16,	15	104	101¾
" 17,	16	114	102½
" 18,	17	100	101⅛
" 19,	18	116	102½
" 20,	19	92	101½

CASE L.

Laccrated Finger with Fracture of Phalanx of Index—Dressed with Clayey Earth—No Pain—Cure in twenty-five days.

Patrick McM., a drayman, æt. 30, had the index finger of his left hand injured by being caught between the side of his dray and a hogshead of sugar, which he was rolling up on his vehicle. The second phalanx was broken and all tbe soft tissues were lacerated, save a small portion of integuments on the palmar surface. He sustained at the time a considerable laceration of the integuments of the third finger of the same band. The accident happened on the 2d of April, and the patient on reaching the bospital immediately thereafter had the parts covered with dry earth and placed in a hand-splint. Complained of no pain after dressing. Under this dressing, repeated every other day, the wounds did remarkably well. By the 13th (ninth day), that of the third finger was entirely healed, and by the 29th (the twenty-fifth day) the patient was given his discharge, as his wounds were then all completely cicatrized.

CASE LI.

Epithelioma of Face—1¼ inches in greatest diameter—Materially Reduced and partially Cicatrized by thirty days' continuous use of Clayey Earth.

Andrew M. was admitted into my ward on the 6th of April for a well-marked epithelial ulcer on the right cheek. He gave the following history of his case: Was 55 years old; a laboring man; intemperate; no cancer or tubercle in his family. About a year and a half previous to his admission he noticed for the first, what he thought was a pimple on the cheek, about an inch in a vertical direction below the inner canthus. This increased steadily in size, became ulcerated, and was at the time of his admission of the form of a Lima bean, by actual measurement 1¼ inches long. It was the seat of occasional lancinating pain. Its base was indurated, and a microscopic examination of a portion removed from its surface showed the characteristic cells of epithelioma.

Dry yellow clay was applied to it, and retained by a piece of adhesive plaster. This dressing, he said, felt very comfortable.

On the 12th, the ulcer was noted as not only looking very well, but had commenced cicatrizing at the inner side. The clay had been renewed each morning, after washing the sore clean with tepid water.

On the 13th, it measured $1\frac{1}{8}$ inches long.

On the 22d, a band of cicatricial tissue had formed across the centre of the ulcer, and the healing seemed to be going on rapidly, as well on the outer and upper as along the inner margins. Same clayey earth used.

On the 25th I tried a different form of earth, some whitish clay, containing a small amount of sand. The next morning the patient said that he had had pain in the ulcer. The clay was found concreted in its margins, and had evidently not agreed with the ulcer.

We then returned to the ordinary clayey earth, and continued its use steadily every day with appreciable benefit to the sore, for by the 4th of May it was reduced to half its original size. The patient, however, became restless, and although I endeavored to persuade him to remain, he left the institution on that day. He had got the idea into his head that I was experimenting with his case.

This patient presented himself at the hospital for some other trouble in the month of January, 1870, and informed Dr. Hunter that the ulcer continued to heal after he left the institution, without any other application. The site of it then presented a well-formed, smooth, and healthy cicatrix.

CASE LII.

Lacerated wound with Subluxation of Thumb—Earth-dressings—Sloughing followed by indolent ulcers—Suspected Necrosis of Phalanx—Resort to fermenting poultices—Healing of Ulcers without any loss of Bone—Good cure, with but partial Anchylosis—No suffering from Earth-dressing—Slight pricking on first application of the Dry Powder.

William K., a shoemaker of intemperate habits, æt. 48 years,

fell from the front platform of a street car, and sustained a lacerated wound of the right thumb with subluxation of the last phalanx. This happened on the 6th of April. The wound was dressed immediately after the reduction of the luxation, on his reaching the hospital, with wet clay. This dressing was renewed every morning. At first this afforded a great deal of comfort to the patient, but in the course of three days the integument became red and swollen near the metacarpo-phalangeal joint, and on the 12th, an incision was made there and some pus evacuated. Wet earth continued. The inflammation persisted after this opening was made, and the integuments and other tissues on the dorsum of the first phalanx sloughed away down to the tendon. The patient always expressed himself as having very little pain whilst this process was going on under the wet earth. There were no evidences of angeioleucitis or phlegmonous inflammation extending up the forearm. The smell from the slough was completely kept down by the earth-dressing.

On the 17th I resorted to the dry earth, which the patient said smarted some when first applied ; but this sensation soon passed off. This dressing was continued for nineteen days, when I returned to the wet earth, as the two ulcers, one on the dorsum of the first phalanx from the slough there, and the other on the palmar surface, where the abscess was opened, seemed to have lost all disposition to heal up any further under the dry dressing. This change seemed to stimulate them for a time. Then they became indolent also, and believing that there was a dead phalanx to come away, I ordered the yeast poultice to be used. The odor from the sores under this dressing, furnished quite a contrast with the absence of all such under the earth-dressings. Continuing these poultices for two weeks, the ulcers diminished in size, and eventually closed without any bone coming away. The thumb returned to its normal size, with slight (very slight) motion at all its joints, and the patient was discharged on the 8th of June. A very good cure.

CASE LIII.

Carbuncle of two weeks' duration, the Pain from which was Relieved instantly after its free division by the application of Dry Earth—Rapid Healing of the wound under the same Dressing.

James G., an oysterman, æt. 56 years, was admitted into the hospital, April 7th, 1869, for a carbuncle which had been two weeks in developing itself. His suffering, he said, had been terrible, keeping him awake constantly both night and day, during the whole of its progress. He had had it poulticed quite steadily from the fourth day, and there was some pus to be seen coming out of three small openings in the centre, when he was first examined by me. The induration of the cellular tissue was then by actual measurement, $4\frac{1}{2} \times 2\frac{1}{2}$ inches at its base. He claimed to be a temperate man, and declared he had always enjoyed good health. He had a remarkably dark olive complexion.

I made a complete crucial incision through this carbuncle, down to the healthy tissue beneath. As this was done without anæsthesia, the agony it caused appeared to be intense, the patient yelling at the top of his voice for the suffering. I immediately then took a scoopful of fine dry clay, and filled the wound with it. The relief it afforded was marvellous, not only to the patient, but to the class and all around, who witnessed it. The patient was emphatic in his declaration that this application had taken away all his pain. He was entirely free from pain for the balance of the day (the operation was done at $11\frac{1}{2}$ A.M.) He slept soundly the following night, a thing he had not done for two weeks before, and was up and about at my usual hour of visiting the next morning. The area of the carbuncle was then seen, after washing off the clay, to be much less. The slough was protruding, and seemed to be thrust out by the contraction of the tissues. The incisions were then by actual measurement with callipers, $2\frac{1}{2} \times 1\frac{1}{2}$ inches.

The dry earth was reapplied, and retained as before by a couple of folds of dry paper and a bandage.

On the 9th, at the end of the second day after the incisions were made, they were found to have diminished to the extent

of three-eighths of an inch for the greater, and one-eighth for the less. Dry earth reapplied.

On the next morning, the fact was noted that the slough was cleaning out rapidly—no sloughing of edges of the incisions.

On the 12th, the core was nearly all away, having been cut off from time to time as it projected. The change in it was not perceptible. Dry earth still used, after washing everything clean.

On the 13th, the sixth day, there was a clean excavated ulcer, 2 × 1 inch, occupying the site of the carbuncle.

Thirteen days later this ulcer was scant $1\frac{3}{4} \times \frac{7}{8}$ inches, with its surface filled up to the level of the adjacent tissue. It then cicatrized rapidly, under the same kind of dressing, and the man becoming impatient to get away, on account of some business he had to look after, was given his discharge on the 7th of May, with all traces of the carbuncle removed, save a small granulating spot of less than half an inch in its greatest diameter, from the presence of which he did not seem to suffer the least inconvenience.

CASE LIV.

Ulcer over Knee-pan—Associated with Thickened Periosteum—Existence of Taint denied—Earth-dressing—Relief at time of application—Recurrence of Pain at night—But trifling benefit from application—Its use Abandoned to meet prejudice of patient—No improvement by other measures until constitutional treatment was used.

Eliza McC. was admitted on the 9th of April for an ulcer on the knee, and gave the following history. She was 27 years old; a tailoress by trade. Had been married about seven years. Shortly after her marriage she became pregnant, and whilst in that condition she had a series of boils in various parts of her body. Then, before reaching her full time, she gave birth to a dead child. She believed the child was dead six weeks before she miscarried, from the fact that she had ceased to feel any motion for that length of time. For three years after this miscarriage she suffered with and was treated

for displacement of the uterus. During this time she did not suffer with any return of the boils. She then became pregnant for the second time, but before reaching her full time she aborted. She had no trouble during or following this pregnancy, and one year and a half later she gave birth to a living child at full term. Soon after the birth of this child she noticed a lump of about the size of a horsechestnut on the left knee, at a point midway between the lower border of the patella and the tubercle of the tibia. This did not occasion her any trouble for nearly two years (six months before coming to the hospital), and during which she was constantly following her trade. It then grew tender, without increasing in size, inflamed, and opened and discharged quite freely, and eventually healed. During this time—namely, three months—it was first poulticed with linseed meal, and after it had discharged it was dressed with some wash under which it cicatrized. She had no more trouble from it, and resumed her work, until about the middle of February, when another opening formed over the patella, and soon after that three more on the other side and above the patella. These had thus far resisted the treatment which had been successful in the first attack. The ulcers had a ragged and suspicious look, were very sensitive, and inflamed. Both the patient's parents and her husband, she said, were living and healthy, but her child, which is still living, has suffered from an early date with enlargement of the cervical glands.

For the first three days after her admission dry earth was applied regularly every morning with relief at the time to the pain; but at the end of each period she appeared in considerable distress, and said the relief given by the dressing had been but momentary; she had not been able to sleep for the suffering, and did not think herself as comfortable as she used to be with a poultice.

I applied then, April 12th, some wet clay, and covered the knee with waxed paper.

The next morning she said that she had been relieved of all pain by the wet clay up to 10 P.M., but after that hour she had suffered a great deal till morning. Ulcers were accurately measured this morning; the largest was seven-eighths of an inch in length and breadth, the others half that size. Ordered,

on account of anæmic appearance of patient, tr. ferri chl., gtt. xx, t. d.

Two days' use of the wet clay had removed considerable of the effusion in the cellular tissue, and I could then detect evident thickening of the periosteum of the patella. Has continued free of pain during the day, but has never failed to have her nocturnal returns of it. Dry earth was then tried for five days with the same result. The patient was up in a chair contrary to my directions. She had then become (with others in the ward) dissatisfied with the treatment by the earth. I therefore ordered a yeast poultice without any change of constitutional treatment or resort to anodynes, but insisted that she should keep her bed. On the following morning she exultantly informed me that she had not had any pain during the past twenty-four hours. I therefore continued the yeast poultice, but on that and the next three nights she got no sleep for the pain. The result was, therefore, so far the same with the yeast poultice as with the earth-dressings. I then ordered twenty drops of Battley's sedative to be given at bedtime, and the poulticing to be continued. The next morning she stated that she had slept pretty well, but had much pain in the ulcers. She had no appetite for her breakfast. Ordered a continuance of treatment with the addition of 2 gr. quinia sulph., t. d.

It was not until after a week's rest in bed, and use of the Battley sedative, that the patient got entirely free of pain.

I then, on the 27th, discontinued the sedative, and for the next week she did well with the tonics and poultices, although she complained with the spells of cloudy and bad weather of some pain.

By the 11th of May one of the smallest ulcers was cicatrized. I then ordered benzoated oxide of zinc ointment in place of the poultice. Under this dressing all the ulcers were finally cicatrized, and the patient discharged, cured, May 17th.

Remarks.—The earth-dressings were abandoned in this case more to meet the caprices of the patient than from any positive demonstration that they did not agree with it. The ulcers were of a character clearly indicating the necessity of fomentation from the very first, but the subsequent resort to such treatment alone did not show that the earth had aggravated the suffering,

but on the contrary the facts that the pain still persisted in recurring at night until anodynes were given, that there was in the history strong suspicion of constitutional taint, and that there was no improvement until the patient kept her bed and received some tonic treatment, all tend to place this case at the worst in only a negative position as regards the action of the earth. The earth did prove acceptable to the patient during the daytime by giving her relief which she did not have when the part was entirely uncovered and exposed, as when she sought admission to the hospital, even admitting that the yeast poultice did this in a more marked manner and cleaned the ulcers more rapidly.

CASE LV.

Ulcer of Leg of four months' duration—Dressed with Dry Earth—No pain—Steady healing—Effect of Earth beneficial—Exuberant Granulation reduced by Pressure.

W. W., a wool-sorter by calling, æt. 27 years, was admitted on the 9th of April for an ulcer of the right leg, following a scratch over the tibia some four months previous. The patient had a plethoric look, and claimed to be perfectly temperate in his habits. The ulcer then measured $2\frac{3}{8}$ inches in length, and $1\frac{6}{8}$ in breadth, was inflamed and irritable, and the patient stated that it had been constantly spreading up to the time of his seeking admission to the hospital. Dry earth was applied, retained by a Scultetus of white paper and a spiral bandage. No pain from this dressing; it felt cool and pleasant. No constitutional treatment ordered. Full diet allowed, and patient ordered to keep his bed. This dressing was removed, and after the limb was washed, was renewed each morning.

On the 12th, three days after admission, the sore had diminished to $1\frac{3}{4}$ in breadth, but was of the same length as on admission. Dressings continued.

On the 19th, the tenth day of treatment, the ulcer was found to have diminished a quarter of an inch more in breadth, but there was no appreciable change in the length. Granulation covering its whole surface, and above the level of adjacent

part. No complaint against the dressings; these continued as at first.

On the 20th, patient stated that for about two hours prior to my visiting him, he had experienced a sensation in the surface of the ulcer as though it was being lightly pricked by pins. Same dressing.

On the 22d (thirteenth day of treatment), the granulations were projecting fully an eighth of an inch above the surrounding part. The dry earth was, therefore, retained *in situ* by straps of adhesive plaster, after Boynton's method. The patient declared this dressing *felt perfectly easy.* It was continually reapplied each day until the 1st of May, when the granulations were so exuberant that the earth was omitted, and the strapping alone continued, and so the treatment went on for ten days, when the granulations were so much reduced that the original dressings of dry earth, Scultetus of paper, and a spiral bandage, were returned to. The ulcer was then reduced to $1\frac{1}{2}$ inches in length, and $\frac{3}{4}$ inch in breadth. Six days' treatment of this kind gave the granulations such exuberance that we had to resort to the pressure of the adhesive strips alone.

The patient was then allowed to go about, and on the 6th of June he asked for his discharge, as he felt well enough to go to work. There was then but a small point of the ulcer left.

CASE LVI.

Laceration of Hand—Closed by Sutures and covered by Earth—No pain—Abscesses from Phlegmonous Inflammation—Pain from them—Yeast Poultices to favor their discharge—Return to the Earth-dressing—Wound closed in thirty-five days.

John E., a laborer, æt. 31, was received for an accident on the afternoon of the 10th of April, and dressed by the resident. On my visit the next morning, I learnt that he had sustained a laceration of the integuments and muscles of the palmar surface of the right hand, without involving any other structure, that there was not much hemorrhage, and that the wound had been closed with silver sutures and covered with clay. On inquiring of the patient, I learned that he was en-

tirely free of pain, and had not had any since the dressing was made. I did not, therefore, then disturb it.

On the morning of the 13th he complained of a great deal of pain, and on removing the dressing, I found not only the hand but the forearm swollen, and tender to the touch, especially along the flexor surfaces. There was evidently phlegmonous inflammation, extending up the sheaths of the flexors. Applied wet clay to the parts, and secured the limb to a splint. Did not disturb the stitches. Ordered tr. ferri chlor., gtt. xv, q. h. 3.

On the 13th removed three of the five stitches which were in the wound, and made an opening on the radial side of forearm on flexor surface, and just above annular ligament, and discharged some pus. The patient had not had any chill. His tongue was coated, but bowels free. Continued same dressings and treatment.

On the 15th the discharge was quite free from the opening at the wrist, but not from the wound in the hand. Could detect deep-seated fluctuation in middle of forearm. Patient said he had "little or no pain" in the limb.

On the 17th I discovered that the base of the first phalanx of the thumb was exposed, and subsequently it became evident that there were some fragments to come away. I therefore, on the 22d, directed yeast poultices to be used, for the purpose of hastening the separation. Two fragments of bone then came away on the 25th. These, from the accounts I received, were probably fragments of the first phalanx of the thumb.

All disposition to further sloughing and burrowing having disappeared, and there being evidently no more bone to come away, I suspended the use of the yeast poultices and returned to the dry earth dressing on the 1st of May. Under this the parts granulated and cicatrized quite rapidly, without the use of any caustic, and the patient was well enough to go home on the 15th of that month.

CASE LVII.

Case of Hæmatocele measuring eight inches in vertical diameter, recurring after a tapping, with threatening Destruction of the Coverings of the Testicle—Free Incision of six inches in length—Evacuation of over half a pint of Fetid Blood—Its Complete Disinfection by Dry Earth—Tunica Vaginalis gangrenous—Subsequent Dressings with the Earth—No loss of Integuments—Complete Cicatrization in twenty-seven days.

John K., æt. 37 years, was admitted on the 14th of April for an enlargement of the left side of the scrotum, suspected to be an hæmatocele. He stated that he was a married man, and had always enjoyed good health; that he had not been drinking any liquor for three months; before then his habits were confessedly intemperate. He denied ever having had any venereal disease. His occupation was that of a cleaner and repairer of steam boilers. He said he got the scrotum injured, pinched, for the first time about three years ago, when at work. It then began to enlarge, and continued to do so steadily for a year, when he received a blow from an iron mallet in the left groin, which was followed by an almost complete subsidence of this swelling. Six weeks after this, however, it began again to increase, but on getting the scrotum squeezed whilst in a boiler, some nine or ten weeks later, it again subsided to its normal size. A little over a month after this it took to increasing for a third time, and continued to do so until about a week before his applying for admission, when, on getting it compressed as before, he says it became reduced in the course of two or three hours to half the size it was, but it began immediately thereafter to swell again, and then for the first time the scrotum became purple in spots. He declared he had never suffered much pain during any of these attacks, or been obliged to give up work for more than two days at a time, until the last, for which he had been laying by for a week.

After examining him in a darkened room, and ascertaining that the left tunica vaginalis was filled with an opaque fluid, I took him into the operating-room and tapped the swelling. Half a pint of bloody fluid was drawn off by this operation. Its evacuation was followed that night by severe lumbar pains,

of such a character as to utterly prevent all sleeping. The operation was done about noon on the 14th, and at my regular visit on the following morning I found the tumor as large as ever (fully seven inches in its vertical diameter), and excessively tender to the touch. The patient had high fever and marked anorexia. This constitutional disturbance continued all through that day (April 16th), and the patient had several distinctly marked chills, the penis and prepuce became infiltrated, and the integuments of the scrotum on the left side were tense, purple, and crackling. I therefore, that afternoon, took a scalpel and laid it freely open from about two inches below the body of the penis to the lowest point of the scrotum, making, by actual measurement, an incision of six inches in length, passing completely through its length into the tunica vaginalis, from which there was discharged fully half a pint of broken-down and horribly fetid blood. As soon as this evacuation was completed, I filled the tunic with dry earth, which had the effect of thoroughly deodorizing it. Its contact was cooling and pleasant.

The same result followed the covering the discharge by the earth. After this earth was washed out I found the walls of the scrotum seven-eighths of an inch thick, the whole tunic, both its *investing* and its *reflecting* portions, specially thickened. The latter were in a more or less gangrenous state. The testicle appeared to be sound. Eight serres-fines were required to check all hemorrhage, the cavity was again filled with dry earth, the scrotum put in a suspensory, and the patient returned to his bed. His pulse that morning was noted as 108, and temperature 104°. The operation was followed that night by considerable pain in the left thigh, along its inner and anterior surfaces, down to the knee, in the groin and small of the back.

On the following morning the pulse was 98, temperature $102\frac{3}{4}°$. Infiltration of both penis and scrotum very much lessened, serres-fines removed, cavity again filled (after it was washed out by a stream of water) with the dry clay. No pain or suffering of any kind.

On the morning of the 19th, about the middle of the third day, I again measured by callipers the walls of the scrotum,

and found them reduced to five-eighths of an inch, over one-third less than what they were on the day of the operation. There was no suppuration going on in the external tissue, but some sloughing evident on the parietal portion of the tunica vaginalis. Pulse on that day 93, temperature $101\frac{1}{4}°$.

Dry earth reapplied as before.

On the 20th I took the temperature of the scrotum itself by putting the thermometer in its cavity, and found it just one degree above that in the axilla, which was on that day $101\frac{3}{4}°$. Pulse (at wrist) 92.

During the next five days the discharge from the sloughing tunic was quite profuse, and was, when suffered to be uncovered by the earth, quite offensive. At the end of that time the walls measured only four-eighths of an inch, and the slough was all away. The size of the scrotum itself had very much diminished, and I inserted two silver sutures at the upper portion of the cut, so as to favor the union there.

Five days later he had some anorexia, and complained of inability to sleep, from sharp shooting pains in left hip. The scrotum was, however, looking very well. In the course of the next two days he became quite icterode, and had constipation with more marked loss of appetite. Profuse sweating at night. Both pulse and temperature increased. He had, however, no chills.

After watching this case for two or three days, it became evident that the complication was one purely of hepatic derangement, entirely independent of the scrotal trouble. He was then given, May 6th, 5 gr. hydrarg. chl. mit., which acted on the bowels, and after its administration both the pulse and temperature were materially improved. No sweating on the following night.

The scrotal trouble steadily improved through all the progress of this, which was evidently a simple attack of hepatic derangement to which he had been subject, so that on May 8th the daily record states there was very little induration or thickening of the scrotal tissues left, and cicatrization going on rapidly.

By the 13th of May (four weeks, less one day, after the scrotum was laid open) the wound was so completely closed

that the patient was allowed to go about without any dressing whatever, and directed to merely sprinkle some powdered clay on points where the epidermis was not fully formed from time to time during the day. I detained this patient in the hospital eighteen days after the cicatrization was thus noted as being complete, for the purpose of watching the further progress of the case. At the end of that time the cicatrice was quite soft and pliant, firmly adherent to the gland, which was entirely free from tenderness and but little larger than its fellow.

J. K., HÆMATOCELE.

Date.	Number of Days after the Operation.	Pulse.	Temperature.
April 17,	1	108	104°
" 18,	2	98	102¾
" 19,	3	92	101¼
" 20,	4	92	101¾
" 21,	5	90	102
" 22,	6	102	101
" 23,	7	84	100¾
" 24,	8	100	100
" 25,	9	88	100¼
" 26,	10	100	100
" 27,	11	84	100
" 28,	12	100	100½
" 29,	13	100	100
" 30,	14	88	100½
May 1,	15	106	102
" 4,	18	102	103¾
" 5,	19	102	103
" 6,	20	100	103¾
" 7,	21	108	102¼
" 8,	22	100	101¼
" 9,	23	100	101
" 10,	24	76	100¾
" 11,	25	88	99¾
" 12,	26	76	99¼
" 13,	27	72	99¼

CASE LVIII.

Three Ulcers of the Leg, of suspicious character—History of Syphilitic infection denied—Dry Earth Dressings—Healing effect not shown

in a positive manner—No Pain on first contact—Nocturnal exacerbations of Pain—Dressings left on for long periods—Their Disinfecting Power.

John B., an Englishman, æt. 35, a bricklayer by trade, applied for admission, and was received on the 19th of April for ulcers of the leg of a year's duration. About ten years previous he had been a patient in the hospital for some trouble of the left hip-joint. Is temperate in habits, and has never had syphilis, but has had gonorrhœa. A year before his applying for admission, the integuments of his legs became red and covered with blisters. The latter broke, and discharged at first a watery fluid, and then purulent matter. The right was not as badly affected as the left, and the ulcers on it healed in the course of three months; but those on the left had resisted all treatment up to the time of his admission.

After his admission the ulcers of the left leg were covered with dry clayey earth. At first the application felt cool, but in about five minutes' time there was a slight burning sensation. This continued for an hour; then from that time until 4 o'clock the following morning he had complete relief from all the pain which he had suffered in the parts previous to his admission. After 4 o'clock that afternoon, and until his dressing was renewed on the 20th, he experienced a burning sensation in the parts more severe than any pain he had ever suffered. The same burning sensation followed the reapplication of the powdered earth, and lasted about half an hour. The previous dressings had been washed off on this occasion. The patient was directed to keep his bed. After this the dressings were reapplied without washing the limb, and the patient did not suffer with pain until after 10 P.M. each day; the pain always lasting until the dressing was reapplied. The earth was then found thoroughly saturated by the discharges.

May 10th. Ulcers much less irritable-looking. Not washed. Earth reapplied.

May 15th. Ulcers well filled by granulations. Leg feels perfectly free of pain.

The earth was continued with evident improvement up to the 29th. Some prepared potters' clay mixed with sand was then applied, and used steadily for six days without any im-

provement. The yellow earth was then used steadily without ever washing the limb, and in three weeks' time there was but two of the original (3) ulcers open, and those were filled by exuberant granulations. Earth continued.

On the 20th of July, being satisfied that the earth would have no effect in reducing the exuberant granulations, I cauterized them freely. Result undetermined, when I transferred the case to my successor.

CASE LIX.

Cauliflower growth of Os Uteri, with offensive discharge—Fetor destroyed by Dry Clay applied to Vagina, and renewed at end of four days.

Margaret K., æt. 56 years, applied for admission to the hospital on the 21st of April. She was a married woman, had had five children, and had been suffering with disease of her womb for ten years, the trouble coming on just one year before the cessation of her menses. This trouble had never been attended with any discharge until eighteen months ago, when she first noticed a bloody discharge, very offensive in its character. This lasted but a short time. Since Christmas the discharge had returned and continued steadily; it was more abundant and offensive than it was the first time. A speculum examination revealed an angry-looking cauliflower growth, involving the whole os, which bled freely at the slightest touch from a probe. After drying the vagina as thoroughly as I could I filled it with some powdered dry clay. When this came in contact with the ulcer the patient said it produced a momentary smarting sensation. After that it was very comfortable. The fetor was entirely destroyed by the application. The patient was directed to remain in her bed. It was not until four days had elapsed that there was any fetor perceptible from the vagina. I then had the earth removed by syringing, and made a speculum examination. The surface of the ulcer was then noted to be looking less angry.

Filled the vagina for the second time with the clay, and this was allowed to remain for four days. The patient having then become discouraged by something said in the ward about her case went home.

CASE LX.

Axillary Abscess Opened and Poulticed for two weeks—Reopened and filled with the White Clay—Some pain—Subsequently dressed with Yellow Clay—No pain—Healed in ten days from time of second opening.

Maria McC. was admitted April 20th for an abscess in the right axilla. She was 22 years old, married, and had been living in a small alley in the lower part of the city. Was pale and thin, but said she had always enjoyed good health. Four weeks previous to her coming to the hospital she noticed a lump of about the size of a horsechestnut in the armpit; this, inflamed and suppurating, was opened by a physician two weeks after its first appearance. Since then she had kept flaxseed poultices constantly applied to the part. There was always a profuse discharge. When she was examined by me it was evident that the opening was not sufficiently free. I therefore enlarged it, and gave vent to more than a drachm of unhealthy (fetid) pus. Whilst this was escaping I covered the parts with some of the white clay; this, when it first came in contact with the wound, she said smarted some, but the sensation was but momentary. The next morning she said it had burnt her after the clay had become thoroughly saturated and allowed the discharge to escape.

April 23d, three days after her admission, she said she was very comfortable—constantly free of pain. The wound was looking well. Dressed with dry yellow clay. Remains in bed.

By the 27th it was noted that there was scarcely any discharge. Parts healing from the bottom.

April 30th. Parts entirely healed up. Time, ten days. Patient discharged. Had no constitutional treatment, but full diet.

CASE LXI.

Lacerated Wound of Forearm involving Median Vein—Hemorrhage stopped by Monsel's Salt—Subsequent dressing with Clay—First

contact caused smarting—No pain—Sloughing confined to parts acted on by Monsel—None of margins—An out-patient—Wound closed within five weeks.

James H., æt. 32 years, came to the hospital on the 28th of April for relief from an injury of the forearm produced that morning by a circular saw. The wound was a lacerated one between three and four inches long, situated in the fleshy portion of the ferearm. It involved the median vein and the sublime flexor. The hemorrhage from the vein had been so profuse that some Monsel's salt was applied by a druggist in the neighborhood of the place where he met with the accident. On his reaching the hospital the vein, which had taken to bleeding afresh, was obliterated by means of torsion, four complete twists being used on both ends to accomplish this object. Dry clay was then poured into the wound, as it was thought impossible to effect any other mode of union than that by suppuration and granulation in consequence of the Monsel having been used. The patient stated that the immediate effect of the contact of the clay was "a good deal of smarting."

The next morning he said the wound felt very comfortable, and that the smarting at the dressing the day before was but for a moment. Dry clay was renewed, and without producing any smarting whatever. On the morning of the 1st of May, at the end of the third period of twenty hours after the application of the Monsel's salt, the surface of the wound presented a most singularly black, very black, appearance, evidently the result of the Monsel intensified by the presence of the earth. There was no fetor or induration save as regards the latter along the line of the vein, where it was very decided. Here there was also some tenderness. On these accounts the earth was used wet instead of dry. Under this dressing the whole surface sloughed itself nearly completely clean in less than three days, but as this was being completed a free hemorrhage occurred (on the night of May 3–4) apparently from a small artery at the bottom of the wound. An interesting fact noted in connection with this sloughing, and noticed by all who were watching the case, was that the margins of the wound were not in any way involved by the process. Dry clay was then used, and the limb secured on a long rectangular splint to prevent

any motion at the elbow or action of the flexors of the fingers. A recurrence of the hemorrhage the next day made it perfectly evident that it came from a muscular arteriole. The obliteration of the vein was then seen to be complete and perfect. By the 9th of May the wound was so thoroughly covered by granulations that I thought to effect their coalescence by drawing the original margins together by stitches of silver wire and gauze and collodion; considerable traction was required to accomplish this thoroughly. The wound was then covered with dry clay, and this was renewed each day without using any water to get off the previous dressing. By the 12th I had to replace one stitch which had cut through. The gauze did not need removal. In a week from this the cicatrization had proceeded so far as to have diminished the wound to one-third its original size. The dry earth dressing was always acceptable to the patient, making the part feel, as he said, cool and comfortable. The patient, owing to the crowded state of the wards, had been treated from the very first day as an out-patient, and by the beginning of June his wound was so completely closed that he ceased his attendance, and we have no exact record of when it was all truly healed up.

CASE LXII.

Obscure Troubles in Hand associated with history of Rheumatism—No relief from Earth or Poulticing, till there was some discharge from the inflamed part.

Mary L., æt. 56, residing in the country, applied at the hospital on the 2d of May, suffering a great deal with her right hand, which was much swollen. She had been affected for some time with rheumatism, which had been confined to the right side of her body, but her hand had never presented this appearance till ten weeks before she came to the hospital; she was then attacked with violent pains in the right mamma; the pain was pulsatile. For it a sinapism was applied, and shortly afterward the pain attacked the right hand. Although the history was rather that of a medical case, the appearance of the hand was that of a threatening abscess. I therefore admitted

her to my ward. The hand was poulticed with flaxseed for two days, during which time she suffered acutely, and required frequent repetitions of hypodermics to give her relief. On the second day the inflammation had become more localized, and fluctuation could be felt on the outer space of the forefinger and thumb. A puncture here gave exit to a few drops (about half a drachm) of sero-purulent fluid. Dry clay was then applied. Its contact was pleasant, but gave no relief to her suffering. Could not sleep that night. Had a hypodermic of one-half grain of morphia; this relieved her till the next morning.

She suffered in the same way on the next and the days following.

On the 9th, she was entirely free from pain all day after the earth was applied. But the next day her sufferings were as acute as ever. Her bowels were regular; appetite poor; had pain in forehead. Still some discharge from the opening made between the thumb and finger.

No improvement following the use of the earth, I substituted the flaxseed poultices on the 13th of May. She however got no relief without being under the influence of morphia, till the 21st. Then there was quite a free discharge from the opening, and both the hand and forearm were materially relieved of their pain. Water-dressings were then tried; with these the discharge ceased on the 26th, and the patient suffered as acutely as ever; the swelling, however, had diminished. The patient gave no evidences of trouble anywhere else. She continued the water-dressings most faithfully, till all the swelling had subsided. She then left the hospital, June 21st, with good use of her hand.

CASE LXIII.

Uterine Polypus removed by wire—Subsequent dressing with Dry Clay, left in Vagina for five days—No discharge or fetor.

Margaret P., æt. 44, a single woman living out at service, had been in poor health for about four years, suffering frequently from rheumatism. Three years later her menses be-

came irregular, and she began to suffer from uterine hemorrhages. These hemorrhages were recurring (at the time of her application for admission to the hospital, March 31st, 1869), whenever she made the slightest exertion. A digital examination at that time revealed a polypoid growth protruding from the os tineæ. The patient was at once admitted to the surgical ward, with the view of removing the tumor. An attack of rheumatism developing itself immediately after her admission, however, compelled the delay of the operation for six weeks. At the end of that time, *i. e.*, on the morning of the 5th of May, a speculum examination was made, and the polypus, an inch and a half long, with quite a broad pedicle, was removed by means of Gouch's double canula wire. The pedicle was completely divided by the wire, and after removing the instrument with the tumor attached, I applied about two tablespoonfuls of dry clayey earth to the os. The next morning the patient stated that she had had a great deal of smarting pain in the lower part of her abdomen, and did not sleep any all night. She did not get any anodyne. Her tongue was quite furred. The pain I attributed to the probable bleeding from the pedicle. There was no discharge, however, from the vagina, and I directed that she should keep perfectly quiet. On the morning of the second day she was entirely free of the burning pain in her abdomen, but complained of lumbar pains.

On the fifth day after the operation I directed her to use a vaginal syringe to remove the earth, which had not then been disturbed since it was first placed there. There was at the time neither fetor nor discharge from the passage. She was also directed to take ʒij of the offic. solut. of morphia. The next morning (May 11), she said she had slept only pretty well, but felt quite free of pain. Two days later I allowed her to be up in a chair; she was then doing very well. No hemorrhage, but had when up some lumbar pains.

This patient remained in the hospital until the 25th of May, when an examination demonstrating her entirely relieved of the polypus for which she had been admitted, she was given her discharge. She had had no hemorrhage whatever from

the uterus since the operation, although she had been up and about the ward. She was, however, still suffering from lumbar pains, evidently dependent upon some uterine displacement.

CASE LXIV.

Compound Fracture of Ulna by a direct blow with a large club—The wound, one and a half inches long, healed in six days, without suppuration, under the Dry Earth.

Matthew F., æt. 42, an hostler, of not strictly temperate habits, was admitted to the hospital on the 8th of May, with a compound fracture of the left ulna. The fracture was situated about three inches below the olecranon, and was produced by a blow from a large club. The laceration, which constituted the fracture a compound one, was one and a half inches in length, and was associated with considerable contusion of the surrounding parts. This wound was closed (after being thoroughly cleansed) by gauze and collodion, and was then covered by dry clayey earth. The forearm was then secured by two splints; an anterior rectangular, and a posterior short straight splint. The patient expressed himself the next morning, at my visit, as being very comfortable, and as having been entirely relieved of pain by the dressing. It was not then disturbed, but was left until the morning of the 11th, when it was renewed, everything looking then very well; there was no discharge or tumefaction. The earth, which had become caked, was picked off, and fresh substituted, without washing the parts. This dressing was left on till the 14th, when, on its removal, the wound was found to have united in the most direct manner without any discharge. The fragments were then noted to be in good position.

The case was subsequently treated by splints alone as a simple fracture. He made an excellent cure, and was discharged on the 26th of June.

CASE LXV.

Compound Fracture of the Leg—Originally dressed with adhesive plaster and Smith's anterior splint—Dressings changed to fracture-box and Earth on second day, when the limb had become swollen and painful—No appreciable effect from the change—Death on third day, apparently from venous stuffing of limb—No autopsy allowed.

Robert H., an Irish laborer, æt. 45 years, was admitted on the 7th of May, for a compound fracture of the right leg, which had been produced that day by the falling in of a bank of earth under which he was digging. The fracture was an oblique one through both bones, just below the junction of the middle and lower thirds of the limb. The wound in the soft parts was an inch long, and communicated directly with the seat of fracture. The resident physician, who received the case, closed the wound with a strip of adhesive plaster, and suspended the limb, without any other dressing, in Prof. N. R. Smith's anterior splint.

This dressing was not disturbed by me at my visit the next morning, as the patient did not then complain about it. But on the following morning the leg and foot had become very much swollen, and the patient was complaining of its being very painful. He had a marked rigor the night previous about 12 o'clock, and his pulse at my visit this morning was 120; temperature $103\frac{1}{4}$°; tongue was furred, and he complained of considerable nausea. I removed the limb from the splint, and found it very tense and ecchymosed. Both arteries were distinct at the ankle. I removed the plaster and then suspended the limb in a fracture-box filled with dry clay. This he said was very comfortable.

At my visit the following morning, I found him in a dying condition; he had another rigor in the night. His pulse was 140°, and so feeble as scarcely to be perceptible at the wrist. Respiration 36; temperature $103\frac{1}{2}$°; was sweating profusely. Conjunctiva slightly icterode. Both the thigh and the leg were enormously swollen. The poor fellow died that afternoon at the end of the third day after receiving the injury. There appeared from the history that a hemorrage had taken place. No autopsy was allowed.

CASE LXVI.

Hæmorrhoids removed by Ligation through their Bases—Earth applied immediately after—Its use objected to by the patient although it occasioned her no pain—Great pain after its discontinuance—Slow recovery—Patient discharged for drunkenness and misconduct sixty-three days after the operation, the ulcerated points still being unhealed.

Rose D., æt. 33, a widow following the occupation of chambermaid, was admitted on the 1st of May for hæmorrhoids. She had suffered with constipation of such a character for over a year as compelled her to a daily resort to purgatives, and with this condition she had, for some time before discovering the piles, an irritable ulcer on the verge of the anus. About three weeks before her admission she discovered, for the first time, on lifting some heavy articles, the presence of the piles.

After she had been ten days in the hospital I removed the mass of hæmorrhoids by three separate ligatures passed by Busch's instrument through their base, and clipping their crowns off after they were thoroughly strangulated. I also, owing to the excessive sphincterismus, made a subcutaneous division of the muscle. Dry clay was applied, and the patient was given a teaspoonful of the solution of morphia to bind the bowels. She slept well that night. Did not like the idea of using dirt for an application to her person. The remains of the piles were therefore left alone. At the end of fifteen days the ulcers following the operation were still sloughing and quite painful. The ligatures had entirely detached themselves. The points of ulceration were still discharging at the end of sixty-three days from the time of the operation, when I was obliged to dismiss the patient on account of misconduct. She had become intoxicated and created a disturbance in the ward.

CASE LXVII.

Extensive Scalds with Vesication—Burn of second degree—Dressed after removal of Cuticle by Dry Earth—Temporary relief of Pain by first,

and its permanent removal by second application of the Earth—Patient died at end of the week from mania a pôtu—The blistered surfaces were then well healed.

Henry G., æt. 34 years, was scalded on the evening of the 14th of May by the breaking of a vat filled with boiling water. He was immediately conveyed to the hospital, and the extent and character of the injury he had sustained was found to be vesication of the outside of the right leg, its whole length, and of the dorsum of that foot. On the left leg there was a surface of about six inches square also vesicated, and there was a slight scald (merely rubefaction) of the outer portion of the left arm. The blebs on the legs were large, but seemed only to involve the cuticle. They were freely opened, the cuticle removed, and the denuded surfaces were then dressed with dry clay by the resident physician. The patient also had a hypodermic of one-fortieth of atropia, and at bedtime two teaspoonfuls of the officinal solution of morphia.

His report the next morning was that his left leg had smarted him a good deal during the night, but that the rest of the injured parts were free of pain. I dressed the limb that morning, and ruptured some new blisters on his left leg, and on the next morning he stated that the scalded parts had been entirely free of pain, and that he had rested well through the whole night, without any anodyne.

He gave the same report of himself at my visit on the morning of the 17th. On the morning of the 18th he manifested some tremor and evidences of mania a pôtu, from which he died in a convulsion on the night of the 21st, just one week after the receipt of his injury. The scalded surfaces were then well healed, and had apparently never occasioned him any distress after the first period of twenty-four hours.

CASE LXVIII.

A trifling but painful Scald, with Vesication over Tendo Achillis—Pain permanently relieved by the Earth-dressing.

Michael B., æt. 26, employed in a distillery, was scalded on the evening of the 13th of May by the bursting of a vat of

boiling water. The injury was confined to a space of 3 × 4 inches over the tendo Achillis of the left leg. He did not, in consequence of the trifling extent of the injury, seek admission at once to the hospital, but applied linseed oil and lime-water to the part at his own home. His suffering was, however, so great during the following night that he came the next morning to the hospital. Here the scald (one of the second degree) was dressed with dry clay. Its application relieved him at once of the pain, and the following morning he reported himself as having been entirely free from suffering, and having had a good night's rest without any anodyne. The dressing was renewed each morning without washing the part. He had no pain in it, and on the fourth day he was walking about the wards; and on the afternoon of the fifth day (May 19th) he felt well enough to go home. The parts were then well covered by new epiderm, and he was discharged cured.

CASE LXIX.

A Ragged Wound of the Face, two inches long, to which seven ligatures and four stitches had been applied—Healed in eight days by the continuous contact of Dry Earth, without washing the part during that time.

Dennis G., æt. 30, of temperate habits, was cut on the face by a knife in a fight on the 18th of May. The wound was a ragged one, about two inches long on the left cheek, in a line with the ala nasi. A physician who was called in at the place where the injury was inflicted applied seven ligatures before he succeeded in arresting all the hemorrhage, and used four stitches to close the wound. The patient was sent to the hospital immediately afterwards, and without disturbing the stitches or ligatures dry earth was applied all over the wound. At the end of forty-eight hours I removed the stitches. The patient expressed himself then as having been entirely free of pain since the first dressing. The dry earth was renewed each day without washing the wound, and the patient was entirely free of pain. By the 23d it was completely cicatrized, and the patient allowed to go home.

CASE LXX.

Chopart Amputation for Railroad Crush of Foot, occurring whilst the patient was dead drunk—Failure of Torsion—Acupressure, Serres-fines, and Dry Earth used—Secondary Hemorrhage—Pain from Hemorrhage and Stuffing—Stump *filled* with Clay—Microscopic Examinations, by self and Dr. Tyson, of the effects of Clay on Pus—Thorough Testing of the Disinfecting and Healing Powers of the Clay by its prolonged use under very adverse circumstances.

On the night of the 20th of May, Archibald G. had his right foot crushed on the track of the Norristown Railroad, some six miles distant from the hospital. He was lying at the time in a drunken state on the road, and the parties who picked him up and conveyed him to the institution stated that he had lost very little blood from the accident. On examining him, it was found that the integuments had sustained so much laceration as to make it barely possible to perform a Chopart amputation; this was, however, attempted the next morning, when the patient was in a state of fair reaction. Torsion was tried, to secure the vessels divided at the time, but signally failing (possibly from my want of practice in its use), acupressure was then successfully used on the dorsalis pedis; and the internal and external plantars, the smaller trunks, were secured by serres-fines. Both flaps were scant. To allow of better coaptation, the tendo Achillis was divided subcutaneously. The whole operation was done with the patient fully under the influence of ether, and to protect the wound until I could close it up, after he had thoroughly reacted, I covered it over with some dry clay.

The permanent dressing was made six hours later, when it was necessary to apply a fourth pin on the inside of the heel, to arrest the hemorrhage from a vessel there. The dressing then made was silver wire stitching, gauze, and collodion, and the stump, when thoroughly washed off and dried, was put in a fracture-box, and buried there in dry clay. On the following morning, it was estimated from the quantity of moistened earth around the stump, that there had been about an ounce and a half of oozing. As there was no pulsation transmitted by any of the pins, except that on the anterior tibial, they

were all, with that exception, removed, and the limb replaced in the box of dry clay, as at first. The contact of the earth was very comfortable and agreeable to the patient. Pulse 100, temperature 104°. Had slept under effect of atropia, administered hypodermically.

On the morning of the 23d, the pin on the anterior tibial was removed without any hemorrhage occurring. Pulse 94, temperature $103\frac{1}{2}$°. Had slept well; neither the stitches or gauze removed; the stump was *not washed;* dry clay renewed; everything seemed to be doing well.

May 24th. Pulse 90, temperature $102\frac{1}{2}$°. Had had another good night's rest. No pain; has not had any since first dressing.

May 25th. Pulse 92, temperature $100\frac{3}{4}$°. Had this morning some nausea. No pain or tenderness about stump; did not wash it, but re-covered it with the clay.

May 26th. Evident stuffing of stump. Removed stitches and gauze, and turned out considerable clot between the flaps. Discovered the central portion (for about one inch) of the dorsal flap to be gangrenous; no odor about it, but it was livid and insensible. This was the portion of this flap about which I had some misgivings as to its retaining its vitality when I did the operation. The rest of the margins looked very well. The patient had experienced during the greater part of the day previous, a burning sensation in his stump. After wiping the surfaces as clean as possible with some dry oakum, allowing the flaps to gape wide apart, I filled the space between with some dry clay, for I now had no reason to look for any direct union. The burning sensation was entirely and almost immediately (within three minutes) removed by the contact of the earth. The patient's tongue was dry and somewhat furred; his bowels costive. Pulse 110, temperature $103\frac{3}{4}$°.

On the 27th, I suspended the box containing the stump, dressed as heretofore, and the patient expressed himself as decidedly more comfortable, from the facility it gave him of moving in bed. No pain about stump. Bowels moved by enema. Stump not disturbed.

May 28th. Tongue dry and covered with brown coat. Skin hot and dry. Bowels not moved. Has had a dull, aching

pain in the stump since yesterday 3 P.M. Had given him by the nurse at bedtime, two teaspoonfuls officinal solution of morphia, but got no relief from his suffering. No odor about the dressings; dressings changed. Pulse 100, temperature $103\frac{1}{2}°$.

May 29th. No pain in the stump since yesterday's dressing. On washing the stump clean this morning, discovered a portion of the plantar flap covered up by the margin of the thickened derm there ($2\frac{1}{2}$ inches long, $\frac{1}{4}$ inch deep) in a sloughing condition. Pulse and temperature the same as yesterday.

May 30th. Pulse 94, temperature $101\frac{1}{2}°$. No change. Line of demarcation well defined. Trimmed off the slough as well as possible, filled the stump in with dry clay, and replaced it in the box. This dressing was not disturbed for forty-eight hours, until

June 1st. There had then been no smell of pus or of putrefaction about the parts. The portion of clay put between the opposing surfaces was dampened through its whole depth and thickness, and was carefully removed nearly entire, in its wedge-like form. Its sides were covered by a thin film of yellow pus, and the surfaces from which it was removed were covered with healthy granulations. A microscopic examination made after the dressing of this ward was completed, that is, within an hour of the removal of this mass of clay, showed that on those surfaces of it which lay in contact with the granulations, the pus-corpuscles were perfect and well formed; that immediately beneath those surfaces these bodies were shrivelled, and in some instances ruptured, with their contents protruding or budding through; that deeper down, the nuclei only could be detected; and that still deeper—but where the earth was positively wet—there were no microscopic traces of pus whatever.

June 2d. Bowels opened this A.M.; the second time only since the patient's admission; has had no medicines given for the purpose. Has had a burning pain up the inside of the leg during last twenty-four hours. The limb was swollen and tender along the track of the vein there, and an indistinct sensation of fluctuation being experienced just above the malleolus. I made a deep incision through the superficial fascia, and

evacuated a considerable quantity (over one ounce at least) of pus. Pressure on the inside of the limb from the knee downwards, made the discharge come more rapidly, and indicated evidently that there was considerable burrowing up along the deeper planes of tissue. The burning pain although somewhat abated, after the earth was put on this morning, continued through the day. Pulse 92, temperature 102°. Dressing same as before.

June 3d. Pulse 80, temperature $98\frac{1}{4}$°. Slept well last night, and is perfectly free from pain this morning. Took one pill cathart. c., last night, and has had his bowels freely moved. Dressing renewed. Slough *not* increased, but not inclined to separate.

June 4th. Has been suffering with a burning pain in the limb since noon yesterday. Pulse this A.M. 96, temperature 99°. The amount of discharge from abscess and granulating surfaces of stump estimated at about two fluid ounces. Ordered an yeast poultice to be applied this A.M., and to be renewed at bedtime, in place of the earth-dressings, for the purpose of hastening the separation of the slough.

June 5th. On entering the ward this A.M., the smell of pus and sour poultice was evident to all who were with me, and was noticed as in singular contrast with the absence heretofore of any offensive smell in the case. The pus had run through the dressings and soiled the bedding, and on taking off the waxed paper and bandaging, there were clearly over two ounces of pus which ran into the dressing-basin. This was the accumulation of the night only, and showed in a very marked manner, when compared with the amount noted in the record of the 4th, the difference between the fermenting poultice and the earth-dressing, in exciting suppuration. The sloughing margin was now perfectly cleaned by the poultice, and we returned to the dry clay dressing. This dressing was very agreeable to the patient until the latter part of the afternoon, and during the night, when he suffered with severe burning pain in the parts about the heel.

On the following morning (June 6th), free vent was given by an incision to an accumulation of pus, detected by very marked fluctuation just behind the tibia. The surfaces of the

flaps now looked so healthy, that I deemed it best for my patient to approximate them close together, by a deep stitch of silver wire, and gauze and collodion, and the stump was then buried in the earth as at first. The earth which had been packed between the flaps yesterday, was carefully preserved, and a part of it sent to Dr. Tyson for microscopic examination. The report made by him in reference to the changes produced by the earth on the pus coincided with my own observations, and will be found fully detailed at the end of the volume, where that subject is discussed.

June 7th. Pulse 90, temperature 100°. Tongue cleaning off. Bowels moved without aid. Has had much less pain in the stump during the last twenty-four hours. Stump washed off; looked very well; redressed with fresh dry clay.

Was so comfortable on the 8th, and the dressing seemed so free from odor, that it was not disturbed.

On the 9th, the stump was taken out of the box and washed clean, and the gauze removed. It was then apparent to all who had been watching the case, that over half an inch of cicatrix had been made at the inner angle since the last dressing. The abscess which had been opened behind the tibia was looking very well; there was no irritation about it; but little discharge. The dressing of clay made on this morning was not disturbed for four days, and the patient expressed himself as very comfortable with it so. The nurse had at my direction added some clay whenever it was noticed that the discharge was coming to the surface. In this way all odor was prevented from contaminating the ward. On uncovering the stump, but without washing it, I found a very marked improvement: the surfaces were granulating up and cicatrizing rapidly.

On the 14th, the granulations at the outer angle were so exuberant that I cauterized them with arg. nit.; abstained from washing the stump until the 17th (eight days), and there was never during that time any odor about, unless when the precaution of keeping the discharge covered with the clay was neglected, and then it could be readily detected, but was always promptly destroyed by some earth being thrown over that which had become saturated. On washing the stump on the morning of the 17th, I found the gauze and collodion applied on the 9th, still firmly supporting the margins of the

flaps in close proximity to each other, but a small accumulation of pus had formed around the inner malleolus. This I opened. His pulse this morning and his temperature were both high; the first 100, the second $101\frac{1}{4}°$. On the following morning they were down: the first to 88, the second to $100\frac{3}{4}°$. Leg was perfectly free from pain. Same dressing used.

On the 22d of June I felt compelled to remove the gauze, which had been on the stump since the 9th, for the reason that the granulations had grown up through its meshes. In taking it off considerable bleeding was necessarily provoked. I then cauterized the surface without washing off the stump, and an examination showed that firm union had been effected up to within half an inch of the margins of the flaps. No change was then made until the 25th, and during the eight days which preceded that date, the same earth had been reapplied without there being any appreciable evidence of its having lost its efficacy in any one respect.

On the 25th I washed the stump and removed the stitches, as they were no longer needed. I then replaced it in the fracture-box, and covered it with fresh clay. This dressing was not again disturbed for one hundred and forty-four hours, during which the weather was more than usually hot and oppressive, the thermometer ranging during the time between 71° and 91°, the mean maximum being 85°, and the mean minimum 76°, and $30\frac{1}{2}$ of these days were cloudy, with $6\frac{1}{2}$ raining, during which $1\frac{1}{2}$ inch of rain fell. Added to this state of things we had the annoyance from the flies, common at this season, intensified by the shutters having all been removed for the purpose of being painted, and there was no means left of excluding the sunlight, and therefore to rid the wards of these pests. To give some idea of the annoyance to which this and the other patients in my ward were subjected on this account, I may mention the fact that a washbasinful of flies, killed by fly paper, was swept up from the floor of one ward alone every morning during this period. Yet, in spite of all these circumstances, this patient expressed himself as very comfortable as regards his stump. It was free of pain and smell, the nurse having been careful to keep the discharge from coming to the surface by heaping up dry portions of the earth over the point where the discharge showed a disposition to come up.

His pulse during this period ranged from 76 to 84, and his temperature from $100\frac{1}{4}°$ to $100\frac{3}{4}°$.

On the 30th the stump was washed and re-covered with fresh clay. It looked very well indeed. It was not again disturbed until the 5th of July, and after that not till the 11th. There was then on the 11th such a small amount of surface to cicatrize that a dressing of clay retained by strips of paper was deemed sufficient. The patient was allowed to be up and about in a wheel-chair on this day. After this the stump was dressed regularly every third day until it was cicatrized, when the patient was discharged, July 29th.

CASE LXXI.

Deep Scald of Leg—Dry Earth applied on fourth day after use of Molasses—Relief when first applied—Return of Pain at night—Injury healed in seventeen days.

Mary S., a German domestic, æt. 19 years, scalded her right leg by upsetting a kettle of boiling water on the 20th of May. The scald extended from the upper third of the leg down to below the malleolus. It was confined to the outside of the leg, and was about four inches in breadth. Before and up to the time of her admission, which did not take place till four days after the accident, molasses was applied, and kept in contact with the injured surface. After admission the molasses was washed off, and the dry clay was applied. It gave her relief at the time to the pain with which she had been suffering whilst the molasses was on. The next morning she stated that the pain had returned during the night. It was, however, relieved immediately on the application of more dry earth. The scald was then evidently a deep one, and occasioning a good deal of suppuration. The earth was always found saturated on its removal in the morning. These effects were noticeable until the 29th, when the patient ceased to have a recurrence of the pain after the dressings had been on some time.

By the 6th of June the limb was completely healed, and the dressings were suspended. The patient left the hospital on the 9th perfectly well.

CASE LXXII.

Deep Palmar Abscess of obscure origin treated by Free Incision and Earth-dressings, both Wet and Dry, with relief of pain by the Earth.

Patrick R., æt. 33 years, admitted May 25th; a week previous to his admission he began to suffer with severe pain in the palm of the left hand; the parts swelled rapidly, and at the time of his admission there was a well-defined collection of pus just below the annular ligament. Through this an opening was immediately made, and wet clayey earth applied. This application was continued for five days, when, the discharge having materially diminished in quantity, dry earth was substituted. The patient stated at this time (the morning of June 1st) that there was a slight burning sensation experienced whenever the opening was exposed to the air, but that it disappeared on the application of the earth, which was cooling and pleasant.

Dressings continued, with steady improvement to the parts and relief of pain, until the 6th; on the night of that day he experienced a great deal of burning pain in the wound; for this there was no appreciable cause, and there was never any return of it subsequently. On the contrary the wound, which was originally nearly two inches long and more than half an inch deep, filled up steadily and cicatrized without any pain, and the patient was discharged, cured, on the 23d of June, after a sojourn of twenty-nine days in the hospital.

CASE LXXIII.

Lacerated Wound of Forehead dressed with Gauze and Collodion and Dry Earth—Immediate and permanent relief of pain—Wound healed without any appreciable amount of Sloughing or Discharge, partly by direct union, partly by granulations—Dressing only renewed at long intervals of time—Wound closed—Patient discharged cured on twentieth day.

William D., a laborer, æt. 42 years, of temperate habits, was received into the hospital on the 25th of May for a lacerated wound of the forehead from an iron crane swinging and striking him at that point. The wound was crescentic in shape, extending about two and a half inches in an oblique direction, and

involved all the tissues down to the periosteum. He had come directly to the institution after receiving the injury, and complained of considerable pain in the forehead, especially at the seat of the wound. The edges of the wound (after it had been thoroughly cleansed) were approximated and retained by the gauze and collodion. The dry earth was then covered over the whole tract, and retained by a piece of dry paper and a roller.

The application of the earth afforded him immediate relief to the pain; and as he retained the dressing very well in place, it was not disturbed until the sixth day (May 31st), when the forehead was washed and the wound noted as looking perfectly healthy; part had united directly, and part was covered with granulations. The amount of discharge during the six days had been so trifling as not to have saturated the earth which was on the forehead. Dressing renewed, and not changed again until the 4th of June. The immediate effect of its application at both dressings was that of a cooling and comfortable sensation, and there was never any pain in the parts whilst they were covered with it. By the 9th the wound was (as shown by the record of that day) healed save at a minute point in its middle. The dry earth continued until the 14th, when the wound was completely closed and firmly cicatrized, and the patient was discharged. The fact was noted in this case that although there was considerable bruising, there was never any sloughing or loss of its margins, and from the trifling character of the discharge there could have been little if any of the deeper parts.

CASE LXXIV.

Adenoid Tumor of Mamma size of a hen's egg Enucleated, Serres-fines, and Torsion to arrest Hemorrhage—Stitches—Gauze—Dry Earth—Direct union throughout save for one-quarter of an inch at inner angle—Some Suppuration there—This Pouch filled with Earth, cicatrized slowly under Earth-dressing—No pain on application of Earth, or afterwards, save one day.

Mary S., æt. 18 years, a factory girl, detected, about seven months before her admission (May 21st), a small round lump

in the right mamma, two inches outside and somewhat above the plane of the nipple. It gave her no pain save after a hard day's work, and then she experienced sharp lancinating pains in the breast. The tumor was steadily increasing in size. No history of cancer or constitutional taint in her family. She was a blonde, well formed and developed, and in the enjoyment apparently of perfect health. The tumor at the time of her admission was about the size of a hen's egg. I enucleated this growth on the 26th of May by a single incision made in the direction of a radius from the nipple, and disturbed the breast as little as possible. The hemorrhage following appearing to come from small vessels only was arrested temporarily by serres-fines and the wound left open for five hours. But one of the vessels at the inner angle bleeding on the removal of the serres-fines at the end of that time when I went to dress the wound, I secured it by free torsion. I then cleaned out the cavity left by the operation of all coagula, brought the edges carefully together, and retained them in apposition by silver stitches, three in number, with gauze between them. Over these I put some dry powdered clay, which the patient said was "cooling" and relieved her of the burning pain of the wound. Did not disturb this dressing the next morning, as everything was doing well. Patient said the clay had relieved the pain, and that she was perfectly comfortable.

May 28th. Had a little burning pain yesterday at the end of the wound near the nipple. Some little tumefaction there. Did not disturb the stitches or gauze. Reapplied the earth; it always feels pleasant and cool, especially when first applied.

May 29th. The clay moistened to the extent of what five or six drops of fluid might do at the point where the tumefaction was noted yesterday. The rest of the wound dry and apparently united. Continued the dressings.

June 1st. Removed the stitches and gauze to-day. Union, except at inner angle. Disposition to form a pouch there. Covered the parts with clayey earth after renewing the gauze.

June 4th. Wound not washed since last note. No pain; doing very well.

Not dressed again till the 11th. Very trifling discharge

from the one point only. All the rest united. Removed the gauze so as to allow this point to gape as much as it would and granulate from the bottom. Covered all with dry earth.

Did not disturb the dressing till 13th. No pain or annoyance. Union firm and complete throughout save for one-quarter of an inch at the inner angle. This point I again closed on the 16th, as it was granulating nicely, by two deep silver stitches, to see whether we could get union of the two surfaces by such contact. Covered the part over with the earth as before, but without washing, every morning.

These stitches did not cut their way through for fourteen days. On the 30th of June there was a small point of exuberant granulations, which instead of cauterizing I applied some earth bound down on the part by strips of adhesive plaster. This gave rise to some pain, but was found to have had the effect of checking the granulations. This spot I had afterwards dressed with the earth retained as in former dressings. It never then occasioned any pain. The cicatrization, however, went on very slowly, and it was not until the 24th of July that this point was completely and firmly united.

CASE LXXV.

Contusion and Laceration of Foot, with Fracture of the Great Toe—Dressed for one week with Warm Water Dressings—Sloughing—Wet and then Dry Earth—Relief of Pain produced by the Dry Earth—Loss of Toe and part of the Head of the Metatarsal—Slow healing of Ulcer under Earth-dressings.

John D., æt. 30, a laborer, was brought to the hospital on 20th of May from Jeanesville, Luzerne County, Pa., where he had been injured the day before by a piece of heavy lumber falling on his foot. The great toe was fractured, and the tissues in its vicinity extensively lacerated. The injury was not, in the opinion of the resident, such as to necessitate amputation. He accordingly dressed it with warm water dressing. This dressing was renewed every day for a week, during which time the patient was constantly suffering pain.

On the 27th I applied the wet earth; the tissues were slough-

ing. This dressing gave him no relief. I therefore substituted for it the dry earth on the 28th. This he said felt very comfortable. This dressing was renewed each morning and the patient was constantly free of pain from its first application. The fetor from the sloughs was effectually destroyed by this dressing.

On the 2d of June the toe came away at the second joint. Continued the dry earth. "No pain." The ulcerated surface granulated slowly.

On the 12th of June a fragment of bone of the size of the index finger-nail came away from the head of the first metatarsal. Continued the dry earth.

On the 4th of July, partial cicatrization; some exuberant granulations. Touched them with solid arg. nit.

The parts were finally cicatrized and the patient discharged July 19th.

CASE LXXVI.

Scirrhus of Mammary Gland—Excision of whole gland—Wound involved at a low estimate 60 square inches of surfaces to heal—Acupressure (four pins)—Metallic stitches—Gauze and Collodion—Dry Earth Dressings—No pain from the Earth—Skin blistered by the Plain Collodion—Subsequent use of it mixed with Earth not followed by such effects—Dressing renewed every day without washing the Wound, except at long intervals of time—Patient up on thirteenth day—Direct Union throughout the greater part of the Wound.

Julia T., æt. 47, was admitted for cancer of the breast on the 2d of June, and gave the following history of her case: Housewife; has had three children; father died of consumption; cause of mother's death unknown; an older sister died of cancer; her own health has always been good; is quite fleshy, and remarkably sallow. During the past summer she first perceived a lump in the left breast. It was then about the size of a horse-chestnut. It has steadily and rapidly increased since then. It now involves the upper two-thirds of the gland (a very large one), is hard, nodulated, but has never, until within a week of her coming to the hospital, been the seat of any pain. The pain since then has been a sharp lancinating one. The skin is perfectly sound, nipple retracted. The greatest measurement

from base to base on either side and over the nipple was about nine inches.

I operated that day, removing the whole gland and the cellular tissue, going down to the pectoral muscle. I made my incisions obliquely downwards and outwards, with the view of securing the best drainage, as the patient could not lie with her head very low. The actual length of the edges of the wound was nine inches. But three pins by the first method were required to secure all the bleeding vessels. Immediately after they were applied I filled the cavity of the wound with powdered earth, and left it until late that evening to dress. I then (about six hours after the operation) washed the wound out very carefully, and applied another pin to secure a vessel which had taken to bleeding since the patient recovered from the ether. She had vomited a great deal after the operation. Closed the wound by five silver stitches and gauze and collodion. Then covered it with a deep layer of powdered earth. This she said felt "cool and nice." Did not disturb the dressing the next morning. Patient was then still somewhat nauseated. No appetite. Had slept after getting hypodermic of $\frac{1}{4}$ gr. morphia, given by the resident instead of the atropia.

On the morning of the 4th I removed all the pins, as there was no pulsation transmitted by them. Did not disturb the dressing any further. The patient was complaining of some burning pains in the wound, which I attributed from past experience to secondary hemorrhage. She had had it through the night. There was, however, no tumefaction about the wound. Stomach still disturbed, and no appetite. Ordered pil. cath. c., as the bowels had not been moved since the operation.

June 5th. Pulse 96, temperature $97\frac{1}{2}°$. Bowels thoroughly moved by the pills. Rested well. No pain. Renewed the earth without washing the wound.

June 7th. Pulse 108, temperature $99\frac{1}{2}°$. Had a return of the burning pain last night at the outer angle of the wound. Some distension at that point. Removed the gauze and stitch holding the parts there, and turned out some coagula, then washed the place out by means of tepid water having a considerable amount of clay in it. This washing felt pleasant, and was in

contrast with the effect of the final cleansing which I gave with plain tepid water. These washings were done with a Thudichum's bottle. In the first of them we noticed quite a large number of oil-globules in the water as it ran from the breast. Renewed the earth as before.

The next morning I found my patient very much better. Pulse 98, temperature $97\frac{1}{2}°$. There was very little discharge from the wound. Applied a strip of gauze over the point from which one was removed on the 7th, and applied more collodion to the others. Covered the wound with fresh earth without washing it.

June 9. Not so well. Pulse 108, irritable; temperature 101°. Cheeks flushed. Bowels constipated. On uncovering the wound and examining it carefully, found the collodion used the day before had blistered the skin, and that there were traces of blistering from the previous use of the article. Patient complained of the pain from it all yesterday. Ascertained also that she had been constantly getting morphia instead of the atropia at bedtime; ordered its discontinuance. Ruptured the blisters and covered their spots with dry earth. This the patient said took away the pain. Reapplied the dressings as before.

The next morning the patient stated she had slept well without the morphia. Pulse 84, temperature $99\frac{1}{4}°$. Some discharge from both angles. Applied two stitches at the outer angle.

June 11th. Pulse 72, temperature $97\frac{3}{4}°$. Direct union has evidently taken place at a number of points. No pain. Some discharge; it is perfectly healthy.

On the afternoon of the 13th (eleven days after the operation) the patient was sitting up out of bed.

On the 14th I removed all the stitches and the gauze, and washed the parts for the first time since the operation. There was then complete union along the whole line of the wound, save for two inches at the outer angle, where she had the burning pains and from whence all the discharge appeared to proceed. Reapplied some strips of gauze by collodion in which I had previously suspended a small quantity of powdered earth. This collodion held quite firmly, but appeared to have

had its contractile power materially diminished by the presence of the earth. Patient did not experience any pain from its application.

The dressings of earth were then ordered to be renewed each morning for ten days without washing the wound. Everything thus, as regards the healing, looked most admirably at the end of that time. There was but one little spot covered by healthy granulations remaining to heal, but from the manner in which the dressings had been secured, flies had got in and deposited larvæ at this point, and I found in consequence some eight or ten maggots there on two or three different occasions. Due care afterward prevented a recurrence of this annoyance.

On the 29th the patient was prepared to go home, as the wound was healed, but complaining of some pain in her left side, she was advised to remain till the next day. In the interim the symptoms of pneumonia developed themselves, and the patient could not leave the hospital till the 10th of July.

CASE LXXVII.

Deep Lacerated Wounds on the Dorsum of Foot, produced by the passage of a Railroad Car obliquely across the Foot—Treated by direct contact of Clayey Earth, with complete relief of pain—Wounds cicatrized under this dressing (with but one washing) in thirty-four days.

A laborer, John C., æt. 46, admitted June 3d, for laceration of left foot, produced by a railroad car passing obliquely over the parts. The bones were not broken. There were two wounds along the dorsum of the foot, each about one and a half inches long; they were both much lacerated, and no attempts were made to effect any approximation in them, but they were covered, as they were found, with dry clayey earth. It gave him no pain at the time, but on the contrary relieved him of all that he had. This dressing was renewed, without washing any off, every morning for three days. He then (June 7th) complained of occasional sharp pains in the wounds. The earth was then washed, and the parts found looking very well.

No signs of sloughing of the lacerated margins of the wound. He had no pain. After this the earth (clayey) was sprinkled every morning over the wounds without washing them. No fetor. Very little discharge. The wounded surfaces evidently diminishing in size.

Washed the foot off on the 27th. Found the wound on outer side of dorsum cicatrized completely across in two places; that on the inner much diminished in size. Reapplied the earth, a small quantity, and retained it by a strip of adhesive plaster. Has complained of no pain, but of a numbness in the great toe.

July 7th. Both wounds completely cicatrized. Patient discharged.

CASE LXXVIII.

Deep Burns of the Forehead, Face, and Right Upper Extremity, by Coal Oil—Dry Earth afforded only temporary relief of pain—Maggots in the Sores from carelessness—The Earth-dressings abandoned—Carbolic Acid Solution substituted—Its failure to prevent the Development of the Maggots—Return to the Earth-dressings—The Development of Tetanus three days after the washing and first use of the Carbolic Acid Solution.—Death on sixteenth day.

During the evening of the 7th of June, a laborer of intemperate habits was assailed, whilst lying on a sofa, by a drunken woman with a lighted coal oil lamp. She threw the lamp towards his head. It struck on the back of the sofa, and breaking, its contents in a state of ignition were scattered over his forehead, face, chest, and right upper extremity. Nearly the whole of the last-named part was burnt, in some places through the whole derm, in others so as to produce very large blisters. The whole of the face and forehead were deeply burned. On the nose down to the bones, and over the eyelids through the true derm; and on the forehead, ears, and about the mouth, there were large blebs. He was immediately brought to the hospital; there, after all the blisters were ruptured, the burnt parts were well covered with powdered dry earth. The arm was placed in a box filled with this earth.

On the following morning, at my visit, I found him very

restless and in evident suffering. His faee had but little earth on it, and he had extrieated his arm entirely from the dressings, and he deelared he had not experienced any relief from the *burning pain;* he admitted "that the earth felt cool" when first applied. He had had no anodyne.

On the seeond day he expressed himself as having suffered a great deal of pain in the arm during the whole twenty-four hours previous, but was eomfortable about the faee. Two of his friends, who had stayed with him, having been instrueted, had kept his faee eonstantly eovered with the dry earth, and had sueeeeded in keeping his arm in the box. On uneovering the arm, I found a large bleb oeeupying the whole palm of the hand, and filled with *coagulated* lymph. This lymph was aetually half an ineh deep, and there were a number of smaller blisters of the same charaeter on the forearm. He designated these points as the special seats of his sufferings. After opening them and sprinkling the powdered elay freely on, he experieneed the same eooling feeling he had at first. The following morning, however, he expressed himself as having had a very suffering day and night from these same points. All the earth eovering them was thoroughly saturated with the diseharge. From his faee he experienced no ineonvenienee, save from the powder keeping his eyes closed and getting into his mouth. The earth was very thoroughly eaked on his faee, but not wet. There had evidently been a eonsiderable amount of diseharge from all the burnt points. None of the parts, however, were washed, but merely re-eovered by elay. His friends expressed their inability to keep him covered with the fly-netting, or to prevent the flies annoying him.

On the fifth day after his aeeident, the patient deelared "the parts had been quite free of pain during the twenty-four hours previous." They had been kept thoroughly dry by the earth. He was ordered a poultiee to the faee and forehead, to get away the caked earth with as little pain and annoyance to him as possible. The tumefaetion of the face was evidently subsiding.

On the following morning (that of the sixth day), the poultice was found to have answered its purpose, and on eleaning his face (the first time since his admission), the fact was elearly

established that the eyeballs had both escaped injury. The burning pain annoyed him about the wrist during the night previous; the earth around it was fully saturated. Fresh earth was applied to that part, with relief to his suffering He begged to have more freedom for his face, and to be allowed the use of his eyes; a simple water-dressing was applied.

June 14th. Face and head not so comfortable; after they were cleansed, the earth was reapplied, and the patient expressed himself as relieved by the change. He had been greatly annoyed by the flies when he had the water-dressing on the day previous. The arm and hand not yet washed; the earth reapplied to them. The patient was taken down stairs to a private room which could be well darkened, so as to rid him as far as possible from the flies. There he was left by the nurse almost entirely to the care of friends who volunteered to watch him carefully. They were, however, far from constant in their attentions, for on more than one occasion during the next two days I found him without any one near him, entirely uncovered of both bed-clothing and fly-net, with the discharges oozing through the earth at various points, and the flies feasting on it. The result of such neglect was the development of maggots around the eyes and ears, on the margin of the burn at the upper end of the arm, and between his fingers. These I directed to be washed off and the earth reapplied, but on the following morning there was a fresh lot, and as it was evident there was no prospect of my injunction to keep all the burnt parts completely covered with the earth, I determined to abandon its use, and ordered a solution of carbolic acid, one part to twenty-eight of glycerine, and then tepid water, to be applied on cloths and covered by waxed paper.

On the following morning I was disappointed to find a fresh lot of the maggots; the patient had evidently been neglected, as heretofore, by those around him. His sores were partly uncovered, and the flies were tormenting him horribly. I then (on the 18th of June), after washing with carbolic acid solution, reapplied the earth and adopted some more reliable measures to have the parts kept constantly covered by it. On visiting him in the evening, I found things much better. But on the following morning, my resident mentioned the fact that the

man had experienced some difficulty in deglutition, and on investigation it was discovered that there was positive trismus and other evidences of tetanus. The ulcerated surfaces were, however, entirely free of maggots, a circumstance clearly due to the strict observance of my injunction to keep the parts constantly covered with dry earth, which had only been done in the last twenty-four hours.

For this complication I ordered in the morning, hypodermic injections of $\frac{1}{20}$th of a grain of Calabar bean every two hours. On a visit to the hospital in the evening (ten hours after this order was given), I found him no better, and I ascertained that he had had three injections of the dose of Calabar. I then ordered the dose to be increased to $\frac{1}{8}$th of a grain every two hours. Of this he got but one before my usual morning visit ($7\frac{1}{2}$ A.M.) the next day. His temperature was then noted 101°. Pulse 132, feeble. On the two days following he got only four hypodermics of $\frac{1}{8}$th of a grain each during the day, and one ounce of beef essence and one of milk punch every two hours, by injection.

On the 23d, in the morning, it was noted that there was "less rigidity of the jaws, but that the patient could not swallow and had cramps in both arms."

He died on the afternoon of that day at 4 o'clock. No autopsy was allowed.

CASE LXXIX.

Cancer of Breast of eighteen months' duration—Complete Excision of the Gland—Acupressure and Torsion used as Hæmostatics—Wound when Coaptated measured seven inches—Dry Earth applied—Never washed off until fourteenth day—Union direct and complete in five days—No Suppuration—No Pain or Suffering of any kind—Photographed on eighteenth day.

Although the following case was one occurring in my private practice, I have no hesitation in reporting it here, from the fact that it was seen at different times by members of the profession, who, I feel confident, can collectively vouch for the correctness of all the essential parts of the statements which I give concerning it; for between the day of the operation, at which

I was assisted by Dr. Charles T. Hunter and Mr. Parvin, a student of medicine, and the fourteenth day after it, when I ceased all attendance on the case, the patient was visited by Dr. Pellekew, of the Russian Navy, Dr. W. S. Ruschenburger, of the United States Navy, Dr. William V. Keating, Dr. William H. Pancoast, and others, whose names I do not at the present writing recall.

Mrs. A., æt. 56, residing at Tenth and Pine, consulted me on the 2d of June, 1869, concerning a tumor of the right mamma, of which she had first detected the presence some eighteen months previous. The hard nodulated character of the growth, the peculiar pain, and the fact that her mother and an older sister had died of cancer, made the case a clear one of malignant disease, and I earnestly urged the patient to submit, as early as possible, to the removal of the breast. Indeed, the fact that the growth was evidently encroaching on the subcutaneous cellular tissue immediately over the nipple made me not only urgent for its speedy removal, but made me give a cautious prognosis as to the ultimate success of the operation in eradicating the disease.

The fact that this woman had buried her husband but a short time previous after he had suffered for months the most horrible of agonies for a similar disease soon decided her to take the risk of the operation, and I accordingly removed the whole gland on Tuesday, June 8th.

The operation consisted in the enucleation of the gland by elliptical incisions immediately above and below the nipple, and extending across the gland, which, when carefully approximated, afterwards gave a linear measurement of seven inches. A pin was used to arrest the hemorrhage from the artery at the inner angle, and torsion for quite a large cutaneous vessel just above the original position of the nipple. No other vessels required securing. Eight interrupted sutures of leaden wire, and tarletan gauze with collodion, which contained twelve per cent. of clay in it, made a neat and thorough coaptation of the wound throughout. Over all this, and for a circumference equal to the original site of the gland, some three or four ounces of dry yellow clay was sprinkled.

This earth was sprinkled on for the depth of about one-half

inch, and was retained in place by a circle of cotton wadding and a broad bandage, pinned tightly round the chest. This dressing was all accomplished before the patient had recovered from the effects of the ether, which was employed as the anæsthetic in the operation. I saw her in the evening, and found her, as she expressed herself, perfectly comfortable. She had reacted nicely, and was entirely free of pain, and so comfortable that I did not deem it necessary to order any anodyne. On the following morning, at my visit, I found her entirely free from anything like febrile reaction or pain. She had slept the night through, and was not conscious of having undergone any operation, save when she moved her right arm, and then she felt some soreness, as she expressed it, in the region of the wound. The earth was found to be perfectly dry, save directly along the line of the wound in the integument, where it was caked for the breadth of one-eighth of an inch, and to a similar measurement in depth. This crust was not disturbed. The pin securing the artery at the inner angle was removed, and fresh earth was sprinkled over the surface to replace that which had fallen off, or been removed by dusting on my part to get a glimpse of how things were doing. This was all retained as in the primary dressing by a ring of wadding and a broad strip of muslin pinned around the chest.

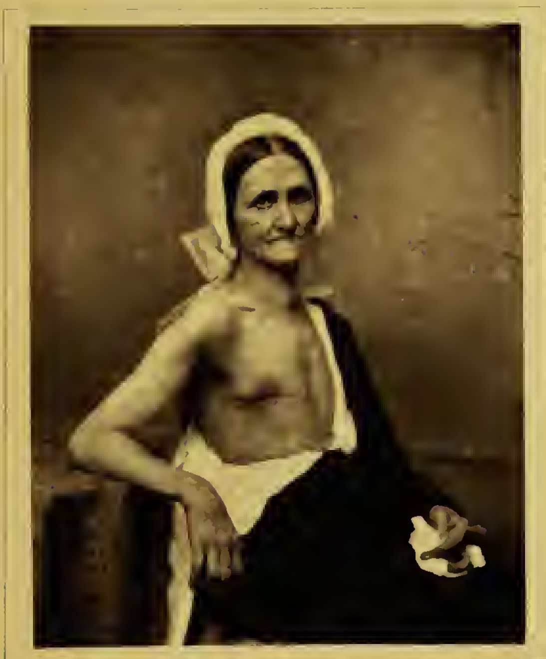
The patient declared herself as scarcely able to realize that she had undergone any operation whatever, such was her actual freedom from pain and suffering of any kind. And this was her report each day afterwards. The dressing was never disturbed save by unpinning the bandage and covering the parts with fresh earth each morning until the fifth day, when I renewed the gauze and collodion as a preliminary to the removal of all the stitches on the next (the sixth) day. There was then not a particle of suppuration to be detected. The removal of the stitch nearest the point where I had used torsion on the cutaneous vessel was followed by a drop or two of blood. This oozing evidently continued after covering the parts with the earth, for the next day there was some caking of the earth at that point to an amount equivalent to about half a teaspoonful of the earth, and the integument around this point was discolored and felt a little boggy. There was some tenderness then,

but no heat or discharge of pus even on firm pressure. This point wept for the next five days, less and less each day, however, and on the twelfth day after the operation I detected for the first and only time a minute quantity, really not more than a mere trace, and absolutely not a drop of purulent-looking fluid on the crust of earth when I picked it off the point. From the rest of the track of the wound there had never been any oozing, even of blood, saving after that noticed as caking the earth on the first day.

The union had evidently taken place *directly* throughout the whole wounded surfaces, save at this point where the twisted vessel was situated in the integument, which vessel had probably oozed out the bloody discharge, which escaped through the point of the stitch nearest to it. On the following day there was no discharge whatever, and on the thirteenth day after the operation was performed I gave the patient permission to have herself thoroughly washed, as I then considered the wound entirely and completely healed. The result was to me one of the most remarkable and curious I had ever witnessed. The wounded surface was originally one of not less than forty square inches, and to all appearances it had thoroughly united by the fifth day, when I renewed the gauze and collodion support, save at the point where the bloody oozing had taken place, and even from this point one could scarcely with accuracy say there had been anything like suppuration, as there was none to be detected up to the thirteenth day, at which time I picked off the crust of blood which had been there since the oozing occurred, and on very careful inspection of its under surface the minutest trace of pus was to be discovered.

The tumor was carefully examined microscopically by my friend, Dr. James Tyson, and also by Dr. Joseph Richardson, on the day of its removal, and its malignant (scirrhous) character clearly defined. This patient was photographed on the eighteenth day after the operation.

December, 1871. This patient has never had a sign of a recurrence of her disease.



Woodburytype. *A. P. R. P. Co., Phila.*

CASE LXXIX.

Photographed on the eighteenth day after the operation.

CASE LXXX.

Melanosis of Eyeball—Relief of Pain by direct contact of Clay to Ocular Conjunctiva—Excision—Subsequent Dressings with Clay.

Sarah M. was admitted on the 9th of June, for a melanosis of the right eye. The following was the history of her case: Was 40 years of age; a housewife; had always had poor health; was thin and sallow. In 1859 she had a molar tooth extracted from the upper jaw. This operation was followed by severe pain in the right side of the face, lasting for over three weeks, when a piece of bone was discharged with considerable bloody matter. After that the pain and tumefaction of the face rapidly subsided. Could not recall any other trouble in face or eye, but subsequently the vision of the right eye began to fail, and about three years since she discovered it to be totally blind. This destruction of vision had been unattended by any pain or appreciable disease in the eye or orbit. Two years later disease became apparent in the eye in the form of dark-colored growths in ocular cellular tissue. Shortly before and since then, she has had constant and severe pain in the eye; was complaining of it at the time of her admission.

The melanotic character of the disease was then very well defined. After she got into the ward I covered the eye with powdered clay, putting some in through the palpebral commissure on the ball itself. The patient assured me that it relieved the pain. The earth was then secured in place by a bandage across the forehead and cheek.

June 10th. Had remained tolerably free of pain since the earth was applied. Renewed the application.

June 11th. Perfectly free from pain for last twenty-four hours. Did not reapply the clay.

June 12th. Had considerable pain in eye during the last twenty-four hours. Reapplied the earth; it felt cool and pleasant.

June 13th. Has had very little pain since yesterday's dressing. Reapplied the earth.

June 14th. Has had more pain than any time before, when the earth was on.

For the next two days I left the eye entirely free of the earth, and the patient stated each morning that she was suffering constantly with pain. I therefore put some clay on as before. It felt cool as usual, at the time of its application, but the next day she stated, that she had afterwards experienced a dull heavy pain.

Nothing further was done until the 24th, when I removed the ball and its appendages, by a curved scalpel and scissors, whilst the patient was under the influence of ether. On account of the free hemorrhage, I filled the socket with a piece of sponge, and applied over it some dry clay. The pressure produced by the swelling of the sponge excited a great deal of pain, in the course of an hour or two after the operation. This pain continued in spite of atropia until that evening, when it was relieved by the removal of the sponge. No bleeding after its removal. Filled the socket with dry clay.

The next morning (June 25th), the patient said she had not had any return of the acute pain, but that there was a constant soreness in the orbit. Reapplied the clay, filling the socket with it as before. This at the time of its application felt cool and comfortable. That applied the day before had become thoroughly saturated in the course of an hour by serous oozing and lachrymal secretion.

Continued the dressings with the same results. The eye always felt comfortable for an hour after the clay was put in, then she experienced the feeling of soreness, as she designated it. The socket began soon to fill up, the palpebral conjunctiva always presenting an infiltrated and puffy look. This by the 4th of July was noted as having materially disappeared, and the patient was then constantly free of pain. Could then detect some melanotic spots in the floor of the orbit. Could not say that they were new deposits; they might have been left in the operation.

By the 11th of July, it was noted that all appearance of infiltration and puffiness of lids had subsided. Cicatrization complete. Omitted the clay-dressings. Ordered tr. ferri chl. et quin. sulph. Resorted to the earth-dressings, as patient thought herself much more comfortable with them.

CASE LXXXI.

Case of Compound Fracture of the Leg complicated with Wounds over the Heel—Dressed with Dry Earth in a Fracture-box—Considerable Oozing and Stuffing—No Pain from contact of the Earth—Secondary Abscesses—Earth-dressing discontinued after two months' use—Patient cured at end of eight months' treatment.

Andrew L., æt. 40 years, was brought to the hospital on the 11th of June, from Conshohocken (a distance of twelve or fourteen miles), with a compound fracture in the lower third of the right leg, produced by a blow from the crank of a stationary engine which he was attending there. The laceration of the integuments communicating directly with the seat of fracture was over the spine of the tibia. There were also three lacerated contused wounds on the back of the leg and heel. Pulsation distinct in the arteries throughout their courses. There was considerable oozing of dark blood from the wound over the shin. In consequence of the bleeding this wound was left open, but the others were closed by gauze and collodion. The limb was then adjusted in a fracture-box partially filled with clayey earth. No pain from contact of the earth, and none for an hour (during the time of my being in the ward) after the dressing was completed.

The next morning I found him suffering a good deal. The earth in the box had become thoroughly saturated for some inches above and below the point of fracture, showing that considerable oozing had occurred from the wound. This earth was not at all offensive. The fragments of the bones were out of place with marked tilting forward of the upper end of the tibia. Washed off the limb. Reset it in the box filled as before with earth, and then suspended the box so as to overcome the action of the muscles. Then covered the limb completely with more dry earth. The next morning he said he had been much more comfortable during the past twenty-four hours. The limb had, however, worked up so as to expose the seat of fracture. Readjusted it without disturbing the suspension. The next day I found the same state of things. I then altered the points of suspension and covered the limb with more clay. This change answered as to the position of the fragment, but

the limb was as heretofore uncovered at the next day's visit, and the flies had been at the wound. Applied then a solution of carbolic acid in water and glycerine by a cloth (this solution contained 10 m. of the acid to the ounce). Continued the earth to the wounds on the back, as they had not been invaded by the maggots. This plan of dressing was continued for five days. The opening on the shin had then enlarged, and we could discover that the ends of both fragments of the tibia were denuded of periosteum. A slough had also formed of the tissues originally injured over the os calcis. Discontinued the suspension after the 23d of June. Continued the earth in the fracture-box. On the 30th the patient complained of burning deep in the calf of the leg.

On the 1st of July I removed a large fragment of bone (evidently originally detached) from the upper end of the tibia. Made also two deep incisions on back of leg, and discharged some pus and shreds of sloughed tissue. Readjusted the limb in a suspended box and covered it with earth. Ordered whisky, quinine, and tr. ferri chlor.

The limb was dressed in this way every morning from the last date, and did very well for the following week. It looked well; there was no pain; granulations were healthy. On the 7th and 8th of July he had slight chills, but no other evidences followed of his not doing well. On the contrary his wounds all continued to improve. The os calcis, which had been completely uncovered behind, was on the 19th covered by granulations, and on the 26th the wound made on the outer side of the leg was firmly cicatrized.

Examined January 31st, 1869. Wound all closed to a small point.

January 31st, 1870. A. L. visited my office this morning for the purpose of letting me see his leg. (He is still in the hospital, but had been out on a pass since Saturday.) The line of the limb was excellent; there was, however, some inversion of the foot. The bone was firmly united. At the seat of fracture there was a fossa on the shin surface of a size to receive the pulp of my middle finger. It is entirely covered with cicatricial tissue save a small point at the very bottom, from which he says there is still some discharge. There is still

some infiltration in the deep tissues shown by the appearance of the limb, and want of control over the muscles. There is drooping of the foot in consequence solely, I think, of this. There is a cicatrix on the back of the heel. The skin up nearly to the knee is excoriated. This he attributes to his scratching the limb very frequently to relieve the itching. In connection with this he volunteered the statement that the limb was very much more comfortable in the earth-dressing than in the bran which my successor in the case had used; for, he said, the earth kept it cool, whereas his leg sweat a great deal in the bran, and it itched so that he could not help scratching it.

He also stated that the precaution—namely, of wrapping up the whole in paper—taken by me to keep the flies away from the limb was not continued after I left, and that his wound got filled with maggots. The bran-dressing was resorted to after Dr. Hunt, the attending surgeon, had seen the case but twice. The same earth had then been left on for four or five days at a time.

CASE LXXXII.

Tarso-Metatarsal Disarticulation for railroad crushing of Toes—Patient of Intemperate Habits, æt. 45 years, with Diseased Arteries—Failure of Torson as the means of Hæmostasis—Acupressure and Serres-fines successful—Dry Earth as the Dressing—Sloughing—Pyæmia—Death on the seventh day—No autopsy.

Thomas Riley, æt. 45, an Irish laborer of intemperate habits, had his foot crushed on the Pennsylvania Railroad early on the morning of the 13th of June, whilst he was in a state of beastly intoxication. He was conveyed to the hospital shortly after the occurrence of the accident, and I performed a Lisfrane disarticulation with some misgivings, as I expressed them at the time, lest the dorsal covering of the integument would slough from the injured condition which was evident at the time of the operation. The dorsalis pedis and internal plantar arteries were secured by acupressure, after ineffectual efforts were made to use torsion, owing to their brittleness. Eight serres-fines were also used on various muscular and digital branches. The wounded surfaces were covered with dry clay until the

patient could fully react from the ether. He complained very positively that the contact of this earth occasioned him *severe burning pain.*

Seven hours after the operation the surfaces were thoroughly washed and cleansed, the serres-fines removed, and the edges of the wound accurately coaptated and retained by stitches of silver wire, thirteen in number, and narrow strips of gauze, secured by collodion. The stump was then covered by the dry clay. To this application of the earth he did not make any complaint. He was then put to bed, and ordered ʒij sol. morph. s.

On the following morning his pulse was 104, temperature $103\frac{1}{2}°$. Complained of not having rested any. Had had the burning pain in the foot all night. Had disarranged the dressings very completely. Dry earth reapplied by means of a pasteboard box, which was suspended to a Smith's anterior splint.

On the second morning (June 15th), his pulse was 92, full and regular; temperature $102\frac{1}{2}°$. Still complained of the burning pain, and that he could not sleep. Pins removed; same dressings reapplied.

On the third morning, pulse 108, temperature $101\frac{1}{2}°$. Said he had very little of the burning pain during the past twenty-four hours. Had no appetite. Tongue had a heavy white coating on it. Bowels were moved in the night for the first time since the operation. Had a severe rigor this forenoon. Stump considerably swollen. No oozing of blood or discharge. Patient delirious, and had gotten off all the dressing. Sweating profusely. A sweetish odor about his breath and from his skin. Ordered an ounce of whisky every two hours.

On the fourth morning (June 17th), his pulse was 120, easily compressed; temperature $101\frac{1}{4}°$. Another chill this morning. Considerable nausea, and some vomiting. Tongue furred. The stump more swollen and blistered where the collodion had been applied. Removed the gauze and some of the stitches. Very little discharge. Some redness up the leg. The same dressing.

On the fifth day he became so wild that he had to be strapped to his bed. Had two distinct rigors, and there were un-

mistakable evidences of sloughing of the dorsal flap of the stump. The earth all washed off, and fresh reapplied; its power to disinfect the sloughing tissues well shown.

Patient died on the seventh day (June 19th), the delirium continuing of a high grade almost to the last.

No autopsy allowed by his friends.

CASE LXXXIII.

Railroad crushing of Leg—Amputatian twenty hours after the accident—Rectangular Flaps of Skin—Acupressure, two pins—Stump not dressed for five hours—Covered *ad interim* with clayey earth—No pain—Two more pins used at final dressing—All pins removed within twenty-three hours—Some pain in Stump first night—None after—Slough over end of Tibia—None of Edges of Flaps—Death from Pyæmia on fifteenth day.

Jno. McG., a laborer, æt. 50 years, fell from a car on the railroad near Chester, on the 14th of June, and the car passing over his right leg inflicted a compound comminuted fracture of both bones, just below their middle. He was not brought to the hospital, a distance of over twenty miles from the place of accident, until the next morning; and early in the afternoon of that day the limb was amputated through its upper third by two rectangular flaps, composed simply of skin and subcutaneous cellular tissue; the flap on the dorsum was made about one-third the circumference of the limb, and the other half that length. Spine of tibia sawed off obliquely. Torsion was then attempted as the means of closing the vessels; but their coats were found in such a state of degeneration, that one full turn of any one of them sufficed to break off the piece held by the forceps. Two acupressure pins were then applied by the first method—one answering to secure both the posterior tibial and the peroneal; the other the anterior tibial. Some serres-fines were used to secure muscular branches. A temporary dressing was then made, after the stump had been washed, until the patient should thoroughly react from the ether. This consisted simply of filling the stump with dry clayey earth, and placing it on a pillow. I

saw the patient that evening at 6 o'clock, five hours after the operation, and he expressed himself as very comfortable. Had no burning or other pain in the stump. Clay between flaps partially saturated. Washed it out, and removed the serres-fines. Two of the vessels secured by them bled freely, and required two additional pins to close them. Then coaptated margins of flaps by silver sutures, gauze, and collodion, and covered the stump with dry earth.

June 16th. Pulse 108, temperature 103½°. Was free of pain in stump till towards morning; then had some, but not much, of a burning character. Did not disturb the dressing any more than necessary to remove the pins. This was done at noon, twenty-three hours after the operation.

June 17th. Pulse 100, regular, fair volume; temperature 101½°. No pain in stump; none since the removal of pins. The amount of discharge from it just sufficient to dampen a good handful of the earth.

June 18th. Pulse 100, temperature 101½°. A couple of the sutures were taken out at the inner angle, on account of tumefaction there. Patient complains of no pain in the stump. Has difficulty in micturition. Has suffered for years with stricture. Ordered the catheter to be used. Did not wash the stump, but renewed the earth around it, and put it in a box, which I suspended by means of a Smith's anterior splint.

June 19th. Pulse 92, soft; temperature 102½°. Bowels constipated. Ordered an enema. Earth renewed without washing. Evidence of sloughing setting in on the anterior face of stump over the end of the tibia. Renewed dressing. Ordered 8 grains quinine, 6 ozs. whisky, and beef essence.

During the next three days this patient grew rapidly worse. Disposition to slough over the end of the tibia positively defined. Incontinence of rectum constant. Was delirious at nights. Removed all but two of the stitches. No sloughing of edges or flaps. No odor from stump. Dry clayey earth continued.

June 23d. Patient's face presents a pinched look. Evident emaciation going on in his body. No control over sphincter ani. Still requires the catheter. During the night he complained of some abdominal pain.

June 26th. Same symptoms and conditions noted for last three days. The slough has now separated over the end of the tibia, exposing the bone entirely denuded of its periosteum. No sloughing of edges of the flaps. From this date symptoms of septicæmia became more and more marked, and the patient died on the night of the 29th. No autopsy obtained.

CASE LXXXIV.

Wound in the Thigh, made in tying the Femoral for Aneurism—Closed by Silver Sutures, Gauze, Collodion, and Dry Earth—No pain for four days—Then Febrile reaction—Burrowing up the vessels—Burning pain—Ligature discharged on the sixteenth day—Wound closed in forty-three days.

Patrick C. was admitted, on the 31st of May, with a tumor on the inside of his thigh, and gave the following history of himself: He was 25 years old; a married man; had always enjoyed good health, and been employed as a laborer in a rolling-mill. Some time previous to his coming to the hospital, he was struck, on the front of his right thigh, a heavy blow by the falling of a large bar of iron. This he felt strained his knee at the time; and shortly afterwards he detected a tumor on the inner side of his thigh, at the point where the artery passes through the tendon of the adductor magnus. This tumor increased quite rapidly in size, and was, at the time of his coming to the hospital, nearly the size of a fist. Both the pulsation and aneurismal whirr were quite distinct. After a consultation, attempts were made at treatment by compression. These were instituted on the 2d of June, and continued for two weeks; first, by digital compression, made by the patient himself, thirty or forty times a day, with the limb forcibly flexed; then by a tourniquet, for an hour or more at a time, but without any appreciable benefit; on the contrary, the patient complained of it greatly increasing the pain in the vicinity of the tumor, and finally begged for some other treatment. I, therefore, on the 16th of June, tied the femoral at the apex of Scarpa's triangle. The wound was closed by silver stitches, gauze, and collodion, and then covered with dry clayey earth.

June 17th. On examining the dressing this morning, I found a small mass of the earth, about the size of a vest button, saturated just where the ligature protruded from the wound, the rest was perfectly dry. Neither swelling nor tenderness about the rest of the wound. Has had no pain sinee the operation.

June 18th. No more discharge from the wound this morning. Had some nausea last night. Tongue eovered with white fur. Bowels moved this A. M., the first time sinee the operation. Has not had any anodyne. Sleeps well. No pain; none from the dressing, which has been renewed onee every day.

June 20th. Experienced some burning deep in the wound to-day. I removed the stitches and gauze, to delay the elosing of the edges of the wound. Applied dry, clayey earth. This application, he said, was followed by some burning. The dressing was not then disturbed for two days.

On the night of the second he had a slight ehill, followed by a profuse sweat. His bowels had then not been aeted on for five days. Dressed the wound as before. Two hours after the dressing he experienced a burning pain in the wound. Pulse 80, temperature $99\frac{1}{2}°$.

From this date out he had some burning pain up along the track of the vessel until the 2d of July (the sixteenth day), when the ligature came away. The wound was then partially cicatrized, and the tumor materially diminished in size. I then closed the opening by two strips of gauze, and reapplied the earth. No pain.

On the 9th and 10th there was some bloody discharge, apparently venous blood. Earth-dressings continued. No pain.

On the 14th I deteeted some burrowing up the thigh, along the sheath of the vessels. No pain. Dry earth eontinued. From this burrowing there was a free discharge on the 17th.

On the 27th, the patient was up and about the ward, with the wound almost eompletely elosed.

On the 29th the union was complete, and the patient given his discharge.

CASE LXXXV.

Penetrating wound of Neck, dividing Inferior Thyroid Vein and Trachea, and three incised wounds of Chest of trifling extent—The latter dressed after first twelve hours with Dry Clayey Earth, and healed by direct union—The former healed partly by Granulation after suppurating and use of poultices.

Bernard D., æt. 25, was waylaid on the night of 17th of June, and, after being knocked down, was stabbed in four different places. He was shortly after conveyed to the hospital by a policeman. There it was found that the most serious and alarming of these wounds was in the neck, and involved the trachea just above the sternum, so as to render him speechless. This wound appeared to have been produced by the knife or instrument striking the patient from an oblique direction on the left clavicle, about one inch to the outside of the sternal articulation, and gliding upwards and inwards it had passed across the inferior thyroid vein, dividing it in two, and then through two rings of the trachea to the right of the mesian line. The external opening of this wound was but three-quarters of an inch in length. It was bleeding very freely at the time of the patient's admission. The other wounds were one through the areola of the left nipple down to the rib; another had penetrated to the rib just at the external margin of the left pectoralis major; and the third had struck the tenth rib about the junction of the inner and middle third, and just on its inferior border.

The resident, who received the case, applied some adhesive plaster over all three wounds. On my visit on the next morning, I found the patient in a great deal of alarm. His neck was swollen from air and blood in the cellular tissue. There had also been a good deal of hemorrhage, and the absence of power to speak seemed specially to occasion him alarm. To determine with certainty the condition of affairs, and whether there was any vessel still bleeding, I enlarged the opening in the neck to about one and a half inches. I then cleaned out all coagula, and finding that the hemorrhage had ceased I closed the wound with three silver sutures, passing the one farthest

on the left well down to the muscle there. Over these stitches I applied strips of gauze and collodion, and then about a table-spoonful of clay. Whilst this was being done the patient was on his back in bed, and to my question whether the earth hurt, he instinctively attempted to say *no*, and was startled on discovering that he had got his voice back.

The adhesive plaster was then removed from the other wounds, and as their lips were agglutinated together in good position by coagula nothing was applied to them but some dry clayey earth.

The patient was very well the next day, and said he had had no pain since I dressed him. This condition of things continuing I did not disturb the dressing, save to put more clay on the neck, until June 24th. By that day, although there was a good deal of swelling of the tissues of the neck, they had ceased to be emphysematous. I then removed the stitches; found part of the wound united, and the rest so filled by granulations as to prevent any entrance of air. Reapplied the earth. The wounds on the chest were all then firmly united.

On the 26th there was some blush and more swelling on side of neck, up along the left sterno-cleido-mast. muscle. This appeared to be the result of the breaking down of the effusion, which had occurred probably from the vein after the wound was closed by the stitches. To favor its escape I had an yeast poultice applied.

The next morning the wound was discharging very profusely from its outer angle. Evidently no opening into the trachea.

Continued the poultices till 30th; as there was then very little discharge, and that of a healthful character, and the tumefaction on side of neck much lessened, substituted then the dry clay. This dressing was continued steadily from that time till the wound was completely cicatrized, and every vestige of irritation in the neck was gone. The patient then (July 23d) received his discharge.

CASE LXXXVI.

Teale Amputation of Forearm in a man of intemperate habits—Torsion and Acupressure as Hæmostatics—Gauze and Collodion and Leaden Sutures as means of Coaptation—Dry Clayey Earth Primary Dressing—Pins removed in fourteen hours—Direct union in greater part of Stump notwithstanding Vesication from the Collodion—No Pain save from these blisters.

Matthew M., æt. 32, was brought to the hospital on the 21st of June for a severe injury of the right hand produced by a circular saw. The saw had passed through the thumb, severing it in two at the metacarpo-phalangeal joint, and then across the dorsum of the hand into the wrist-joint, dividing both the superficial vol. and palmar arch. The patient was a large man, of a sallow complexion, and confessed to being of intemperate habits. I saw him shortly after his admission, and decided on the necessity of an amputation above the wrist. I did the operation within an hour of the infliction of the injury, as the patient was in good condition. It consisted in rectangular flaps, after Teale's method, and I tried torsion by two full turns as the means of controlling the hemorrhage.

This was successful as to the radial and ulna, but failed on the interosseous, and there I had to use acupressure by Simpson's fourth method. When the patient had recovered his consciousness (he was etherized) and was thoroughly reacted, I dressed the stump with leaden sutures, gauze, and collodion, and covered it with dry clayey earth. The contact of the earth, he said, was very grateful.

The next morning his pulse was 80, temperature 100½°. He complained of some pain in the end of the stump, and on uncovering it I found that the collodion had vesicated his skin at the points to which he referred the pain. I removed the pin on the interosseous just fourteen hours after its introduction. The stump was slightly tumid, but not painful. The clay showed there had been some oozing of sanious fluid. Allowed him four ounces of whisky per diem. Clay reapplied in this and following day without washing stump. The blisters from the collodion were not disturbed until 24th. He then complained of their continuing to occasion him distress. His pulse

was 84, good volume, temperature $100\frac{1}{2}°$. I dusted off all the earth possible, and ruptured such blebs as I could detect, and removed the stitches.

The next (the fourth) day he was more comfortable after I ruptured more blebs and applied wet clay to detach the gauze. On the fifth day his pulse was 76, fair volume, temperature $99\frac{3}{4}°$. Gauze entirely detached and removed; little or no tumefaction or tenderness about the stump, save at outer angle. Direct union at the inner angle. Reapplied the wet clay. Says it is very comfortable. Has a good appetite. Sleeps well; has never had to take any anodyne. Was up and about the ward. Wet clay dressings continued daily till the 29th. Then there appeared to be some redness along the margins of the dorsal flap; I therefore resorted to the dry clay; this quickly relieved the pain in the inflamed spot.

July 1st. Some gaping at outer angle; no tumefaction or excessive action. Inserted a silver wire stitch to secure close approximation. Continued dry clay. No pain.

July 4th. Detected a small depot of pus, containing, possibly, ten drops, upon the dorsum of the forearm, an inch or more above the end of the stump. Punctured this with a bistoury. Reapplied dry clay. No pain.

July 5th. Removed the stitch at the outer angle; union progressing nicely. Stump not washed.

July 10th. Union nearly complete. Allowed out on a pass to see his friends.

July 17th. Washed stump to day for first time since the 4th (thirteen days). Union firm throughout. Left it uncovered. Discharged patient cured on 21st, thirty days after the operation, with a most excellent stump.

CASE LXXXVII.

Scald of Foot and Leg from falling into a pan of melted sugar in Refinery—Carron Oil applied at the place of accident—Most intense suffering—When brought to the Hospital, Earth applied with entire relief for over an hour—Extensive Vesication—Suffering at the end

of each day removed by the application of the Earth—Photographed on thirty-fifth day.

Thomas P., æt. 40, a thin but well-developed Englishman, with a very fair skin, was brought to the hospital, on the 25th of June, for a severe scald which he had sustained a short time previous by falling into a pan of melted sugar (about 180° F. temp.), at a sugar refinery, in which he was employed. His pants were rolled up, but he had a laced shoe on, at the time of the accident. Some minutes elapsing, after he was rescued, before the shoe was removed, the burn was much deeper around the ankle and foot than elsewhere; the leg, however, was involved up to the tubercle of the tibia. Carron oil was applied to the parts before he was brought to the hospital, and at the time of his reaching there he was in a great deal of suffering. On uncovering the limb, the leg was of a deep red, and large blebs had formed on the ankle and dorsum of the foot. Immediately on getting him to bed, the parts were all covered with dry clay.

The next morning (June 26th), he stated to me that the parts were entirely relieved of the pain by the earth for an hour and a half after its application; but after that time till this morning he experienced a hot, stinging pain around the ankle and on the sole of the foot, and a dull, heavy pain on the dorsum of the foot. On removing the dressing this morning I found it completely saturated, and several blebs had formed at different points; these were all filled with coagulated lymph, and some with a little serum, which coagulated on its exposure to the air. These blebs were the special seat of the pains of which he complained. The erythematous blush pervading the leg where there were blisters had all disappeared.

I peeled the cuticle off of three-fourths of the surface of the foot and ankle, and then covered those parts with the earth. This relieved him instantly of the burning pain; but in the course of ten minutes after, he had the pain to return. In consequence of this, I directed that the limb should be redressed without washing that evening.

June 27th. States that he had very severe pains in the burnt surfaces, up to the evening dressing, when they disappeared, and with the exception of an occasional dart, he was

free of the pain all night. Reapplied the earth without washing the limb.

June 28th. Has but little pain this morning; none yesterday afternoon. Dressing was not, therefore, disturbed then. Has severe headache this morning. Reapplied the earth. Relieved pain.

June 29th. Has had scarcely any pain in the burnt parts during the last twenty-four hours.

June 30th. Put the leg in a fracture-box to-day with dry earth. Very little pain. Still a large amount of cuticle detached on calf of leg, which became distended to some extent by serum, in the course of the day. Reapplied the earth.

Dressings not disturbed for two days. At the end of that time the leg had worked up out of the earth, and the flies had got at the discharge from the blistered surfaces. Some maggots under the cuticle of the heel. Had not suffered any pain till this (July 3d) morning. Removed all the separated cuticle, uncovering in this way the derm over the entire surface of the calf of the leg. The pain there was immediately relieved by the application of dry earth. Had some hot, uncomfortable feeling in the leg the next morning, which was relieved by a fresh application of the earth. Limb not washed.

The case continued doing well without any material change in treatment, save on the 13th it was washed thoroughly, for the first time since the day of the accident. This was done for the purpose of ascertaining the actual condition of the parts. Granulating surfaces were shown at various points along the leg; and there were quite deep ulcers at the ankles and on the dorsum pedis. The earth was reapplied. It afforded relief to the burning in the parts.

On removing the earth, which had become saturated, each morning, we could notice that the ulcerated surfaces began, after the 14th, to cicatrize very rapidly.

On the 20th, the patient was allowed to sit up. The parts had then ceased to discharge, save on the ankle and back of the foot; they were, however, doing very well. He was now entirely free of pain.

On the 30th of July I had his leg photographed, with all the

crusts of clay which had accumulated on it since the washing of the 13th (seventeen days).

The cuticle was found, on washing all these crusts off (after the picture was taken), to have formed in the most perfect manner, save at the ankle, where there was evidently going to be a somewhat elevated cicatrix.

An examination of this man's leg, some four months after the receipt of his injury, showed a most admirable result. The ulcerated point had everywhere healed without the development of any nodular tissue, save at the ankle and on the dorsum. Even there it had not produced much puckering, nor any sensitiveness.

CASE LXXXVIII.

Burns of both Forearms, Right Hand, and Face, of second degree, from ignited vapor of Benzine—Relief (but temporary at first) of pain from Earth—More persistent relief after Second Dressing—Subsequent history imperfect—Patient discharged at his own request on third day.

Bernard H., æt. 28, claiming to be of temperate habits, was burnt, on the 27th of June, in a distillery, by the ignition of the vapor of benzine. His face was but slightly involved, a few blebs involving only the epithelial layer, being the result of the injury there; but the right forearm and dorsum of the right hand were extensively involved, as also the left forearm, by a burn of the second degree. He was, shortly after the accident, brought to the hospital, and immediately after his admission his injuries were dressed with dry clayey earth, after all the blebs had been ruptured, so as to allow of the free discharge of the effused serum. After this dressing, he was free from pain for an hour subsequently, and until the dressings were renewed the next morning he experienced a good deal of burning pain in the injured parts.

At the dressing on the morning of the 28th, a number of new blebs were found and opened. The dressings renewed.

On the 29th, he stated that he had had very much less pain during the previous twenty-four hours than he had had before

that time. The parts were not washed off, but fresh earth was applied. The application was perfectly comfortable.

June 30th. The patient doing well, and requested his discharge.

CASE LXXXIX.

Varicose Ulcers of both Legs—That of the Right measuring $3 \times 3\frac{1}{2}$; that of the Left, $2\frac{1}{2} \times 3\frac{5}{8}$—Dressed with Dry Earth—Scalding pains followed its application—Ulcer of Left Leg healed in seventeen days—That of Right still open on the twenty-seventh day, but greatly reduced in size, and in a healing condition.

Mary D., æt. 35, was admitted, on the 2d of July, for ulcers on both legs.

History.—A single woman, domestic; has been living in the country; has suffered with varicose veins; says she had an attack of erysipelas six years ago in her left leg, and that it was soon after followed by the appearance of ulcers on both legs. These ulcers had been healed several times.

The ulcer on the right leg, situated just above the inner malleolus, measured, at the time of her admission, $3 \times 3\frac{1}{2}$ inches; that on the left, in a similar position, $2\frac{1}{2} \times 3\frac{5}{8}$. The edges of both were irregular and indurated; their surfaces covered by pale and indolent granulations. Pus scanty. General condition fair. She was sent to bed, and the earth-dressing was ordered to be applied. This was done after the ulcers had been freely washed with soap and water. The next morning she complained of having had severe scalding pains in the ulcers ever since they were washed till late in the night. The earth was renewed without washing off the ulcers.

July 4th. Reports that she had the scalding pain after yesterday's dressing, but it was less severe.

On the 5th this pain did not come on till towards evening, although the earth had been renewed in the morning.

On the 6th, the ulcer of the right leg had diminished one-eighth of an inch, both in length and breadth. Some pain during the afternoon.

The same on the 7th and 8th.

On the 9th, she was perfectly free of pain during the twenty-four hours.

The ulcers on both legs then began to cicatrize.

By the 19th, that of the left leg was nearly completely cicatrized; that of the right not doing as well.

On the 22d, it (that of the right) measured only $1\frac{7}{8} \times \frac{3}{4}$. The left all scabbed over.

The next day it was one-fourth of an inch less. Earth continued to it. No dressing to the left.

On the 29th, when I transferred the wards, the ulcer of the right leg was not half an inch long, and was looking very well.

CASE XC.

Compound Fracture of Right Thigh and of the Left Tibia—Dressed with Dry Earth after closing the wounds with Collodion—Perfect freedom from Pain after this dressing was first applied—Profuse Secondary Hemorrhage from ankle on sixth day—Posterior Tibial tied—Recurrence of Hemorrhage two days after the operation—Transfusion performed by Dr. J. G. Allen with his apparatus—Reaction—Amputation of left leg at Knee—Death.

Captain D., æt. 38 years, a sea captain, was conveyed to the hospital on the night of the 3d of July, having been run over by a street passenger car. The accident had produced a compound fracture of the right thigh, with three small wounds communicating with the seat of fracture, and also a compound comminuted fracture just above the left internal malleolus. Both limbs were dressed by the resident by closing their wounds with gauze, and then putting them in fracture-boxes filled with dry earth. He received after the dressing a hypodermic of atropia, $\frac{1}{40}$ grain.

The next morning he was entirely free of pain, and no examination was therefore made by me of the extent of the injuries. The earth-dressings were continued without disturbing either limb until the evening of the 9th; he then had a profuse hemorrhage, which ceased spontaneously before I could reach the hospital. When I got there, however, I turned out the coagula, and removed a fragment of bone, and as the hemorrhage did not recur I resumed the earth-dressing.

July 11th. No recurrence of hemorrhage. Removed the

earth, and cleaning off the wound I discovered another spicula of bone, which I took away. Reapplied the earth. He had no appetite; had had one or two slight chills in the night. Ordered iron and quinine and milk punch.

I was called to him that night on account of the recurrence of the hemorrhage. When I got there I found he had had two very profuse bleedings, which had prostrated him very much. After consultation, I tied the posterior tibial. Continued the earth. It had always been grateful to his wounds.

On the 12th he had two more hemorrhages, which rendered him almost pulseless. In this condition it was determined to try the effects of transfusion. The operation was performed by Dr. Joseph G. Allen, of Philadelphia. The apparatus used for the purpose was that devised by the Doctor. It consisted essentially of a syringe, on the plan of the hypodermic of Pravaz, capable of holding four ounces. With this syringe about six ounces of defibrinized blood were introduced in the veins of the right arm. Drs. Agnew and Hunt also participated with me in the operation. The blood was furnished by a very healthy and vigorous person, my clinical clerk. About half an hour after this the patient had a slight rigor; took forty drops of laudanum. Ordered all the whisky and beef-essence he could take. During the next day he was evidently better. He could retain his nourishment. In the latter part of the day he had two returns of the bleeding, but they were immediately checked by the use of the tourniquet. His pulse in spite of this was fuller and stronger. The foot was evidently becoming gangrenous, and for the sole purpose of keeping away the flies I used clay and coal tar (Phœnix powder).

By the 17th he had reacted so completely that it was decided to remove the left limb. This was accordingly done at the knee-joint by anterior long and posterior short flaps. Two acupressure pins were put on the popliteal, and several vessels were secured by smaller pins and serres-fines. He lost very little blood by the operation. Dry earth was applied to the surface of the flaps until he should thoroughly react. Within an hour after the operation there was some bleeding from the popliteal. I did not, therefore, deem it safe to trust to the pins, and therefore secured that vessel by a ligature.

About six hours after the operation I closed the stump in my usual manner, and covered it with dry clay. The patient was in a good state of reaction; said the earth felt very cool and pleasant.

Was not disturbed at the time of my visit the next morning. Had had a chill. Had another that afternoon, followed by darting pains in the stump, which lasted all night. Was given one grain of morphia in solution and six grains of opium by suppositories through the night. Had more rigor; no sleep. The bandage retaining the dressing was on the morning of the 19th saturated with blood. Had taken about twenty-four ounces of beef-tea and whisky during the previous twenty-four hours, and retained them all. Pulse 126, temperature 104°. Fresh earth applied. Had a hemorrhage from the stump later in the day, and died shortly after, at 1½ P.M.

CASE XCI.

Compound Fracture of Nose with Laceration of the Cheek by the kick of a horse—Fragments of nasal bones removed—Wound closed by Gauze and Collodion, and covered with Earth—Perfect union in five days—No Pain at any time after first dressing.

C. K., æt. 51, a phlegmatic-looking German, engaged as an hostler at the Union Passenger Railway Company's stables, was kicked in the face by a horse on the afternoon of July 5th, sustaining thereby a lacerated wound of a severe character. This wound beginning at the root of the nose extended along the mesian line to the tip, thence across from the base of the right ala some two inches on the cheek. There was considerable hemorrhage, and a surgeon residing in the neighborhood of the place of accident who was called to the case, removed three fragments of the nasal bone, and after arresting the hemorrhage closed the wound with silk sutures and adhesive plaster, and then sent the case to the hospital. When he reached there the plasters were removed, and after cleansing the surface from coagula, gauze and collodion were used to support the parts. The right eyelid was then so much swollen as to render it impossible to examine into the condition of that organ. The

patient did not complain of any pain in the eye itself, and we had no reason to suppose, save from the character of the blow inflicting the injury, that it was at all involved.

Dry earth was then sprinkled over the wound. In the night the patient applied his handkerchief wet with water with the idea, he told me in the morning, of helping the healing. I reapplied the earth, and directed him to keep some constantly over the wound. This he did most faithfully, and as the tumefaction steadily disappeared, and there were no evidences of any local irritation, the crust of clay was not disturbed until the morning of the 10th, that is, at the close of the fifth day from the accident, when I washed it clean, removed the gauze and the stitches, and then found the wound perfectly united throughout its whole length. Its appearance was well represented in the photograph taken that morning. I kept the patient five days longer in the house, without any dressing or treatment, until the tumefaction of the eyelids was sufficiently reduced to determine positively that there was no injury done to the eye.

This patient suffered no pain whatever from the time his wound was kept constantly covered with the clay.

CASE XCII.

Compound Comminuted Fracture of Leg—Resection—Earth-dressing in Fracture-box—No pain—Rigors on and after the eighteenth day—Death on the twenty-fifth day.

Michael McC., æt. 52, was brought from Jeanesville, Luzerne County, on the evening of the 6th of July. He had been injured that morning in a mine by a large piece of coal rolling on his right leg, and producing a compound fracture of both bones just below the middle. The external wound was about three inches long, and there was great overriding of the fragments. An inch and a half had to be cut off to effect reduction. The limb was then put in a fracture-box and surrounded by dry powdered earth; the application of the earth, the patient said, felt very comfortable. It was not disturbed the next day, or that following. On the 10th the whole limb was swollen, but not painful. More earth applied. On the 12th I took

two pieces of bone out of the wound. The patient had had pain, and pus was then evidently forming near the ankle. On the 15th I evacuated this by an incision just above the internal malleolus; I also then made an opening above the original wound. Both these discharged very freely. After these openings were made and the limb dressed with earth the patient was perfectly free of pain, and continued so till the 25th. During that day he had three rigors; had them on the two days following. Took iron, quinine, and freely of stimulants from the 25th.

Died (evidently of pyæmia) on the 31st. No autopsy obtained.

CASE XCIII.

Gunshot Wound of Buttock of trifling extent—The track laid open and filled with Dry Clay—Complete relief of Pain effected by the Earth—A portion of wad removed on the seventh day from bottom of wound—Dry Earth Dressing continued.

Joseph McG., an old man (æt. 60), of intemperate habits, was admitted on 5th of July, for a gunshot wound of the right buttock, the result of our mode of celebrating our natal day. The wound was not over an inch deep, and its points of exit and entrance were, by actual measurement, one and a half inches apart. The track was laid open and filled with dry clayey earth. The earth relieved him entirely of all pain, and he did not suffer after this dressing until the 7th, he then complained of a stinging pain which lasted all that day. The clay had been renewed each morning without washing. This pain only lasted during that day. On the 12th I removed from the bottom of the wound a portion of the wad from the pistol. The wound was then discharging freely; there was no fetor from it when covered by the earth. It was dressed every morning with dry clayey earth. It was cicatrizing rapidly when I gave up the ward, July 29.

COMMENTS ON CASES.

A careful examination of the details of all these cases will, I think, satisfy any one that certain phenomena have had place after the use of the earth as a topical application, which, at least in the majority of them, may be fairly considered either as its direct effects, or as results materially influenced by it. These may be arranged as follows:

I. Effects as to the contact of the earth with the part.
II. Effects on the pain naturally incident to the cases.
III. Its power as a deodorizer.
IV. Its influence over inflammation.
V. Its influence over putrefaction.
VI. Its influence over the healing processes.

I. The effects as to contact may be well considered as those which are (*a*) primary, and those which are (*b*) secondary.

(*a*) The immediate or primary effect of the direct contact of the earth with the part at least cannot be considered as irritating, for the prompt answer of the patient that it made the part feel "cool and pleasant," was so constantly given, that such effects might truthfully be set down as having been almost universal.

Indeed, the only instances where an opposite answer was given (such as Cases LVIII, LIX, LX, and LXI), were those where there was good cause to doubt the honesty and sincerity of the statements made by the patients; for, as will be noticed, the cases occurred together, and were in the hospital at a time when I know there were particularly strong efforts made to prejudice the patients against the application. In other instances, where bleeding was going on at the time of the earth's application, and the blood had no chance for escape, as was

specially noted in Case LXIII (where a uterine polypus had been removed), the patients did complain of a *burning* pain, but this was an effect, not in any way to be assigned as a *special* or direct one peculiarly due to the contact of the earth; on the contrary, it might have occurred without any dressing whatever.

In instances where other measures had been previously used, and to which we are disposed to attribute soothing effects, as bran (Case I), carron oil (Case LXXXVII), and molasses (Case LXXI), the comparisons made by the patients themselves, were in each case decidedly in favor of the earth. And in the first of the two cases of excision of the eyeball (Case XXXII), where I partially filled the socket, after the operation, with the powdered earth, I was amazed to learn that it not only produced no pain or annoyance, but actually occasioned this "pleasant cooling sensation." The result of the contact of the earth in this case was so contrary to the effects experienced by every one, from the introduction of a minute particle of dust into the eye, that I then thought it could only be explained by the fact of the absence of the ball, whereby the most extreme contractions of the ciliary portion of the orbicularis had failed to press the particles of the earth into the sensitive surface of the conjunctiva. The circumstances attending the use of the earth in the other case (LXXX), must, however, ignore all such idea of the manner in which the contact of the earth had failed to excite pain there, for in it the earth was used before the ball was removed, and was attended by a relief even to the pain previously existing in the eye. It would, therefore, now seem most probable that this singular absence of irritation to the conjunctiva, in these cases, was the result of the *bulk* and *kind* of earth used, unless we recognize that the altered nutrition had made the organ less sensitive than natural. The earth was, as will be remembered, put in freely between the lids, and it not only quickly became wet, but being of a clayey character, it formed almost immediately a tenacious paste, so soft and pliant, that even the particles of silica which it contained could not find points of resistance or support, so as to excite the surface of the conjunctiva opposed to them; they were, so to speak, buried almost instantly in the

mass of damp aluminous matter, by the action of the lids, before they could provoke any irritation in the conjunctiva.

(*b*) As to any secondary sensations or irritations dependent on the mere contact or presence of the earth, it was impossible to determine their existence in a distinct and positive manner, so as to distinguish them from those which we will consider under the next head, namely, the pains naturally incident to the morbid state or action in the part, unless we should except one, and that was, where we used a pure article of clay, which did not allow of free absorption of the discharge, but on the contrary formed, by caking, a barrier for the escape of the discharge, and so occasioned pain; or, where the earth of a loamy character was not abundantly applied, and crusting the margins became the source of pain, by being pressed into the part, under such circumstances. This effect we learned to obviate by using the less caking and more absorbing forms of earth, and applying them more abundantly, or more frequently.

II. In the changes produced by the earth on the pains incident to the cases themselves, there were in some instances most positive and unmistakable evidences of a favorable effect; whereas in others evidences of such an effect were wanting, or of a negative character, and in some the earth appeared to aggravate the pain. In this estimate we are not of course to include all the cases, but on the contrary, *only* those in which, from their nature, past history, or subsequent experience with other dressings, after the earth had had a fair trial, we have some just basis to reason on as to the earth's power to prevent, destroy, or alleviate the pain. It may be thought that we ought also, in order to secure the greatest accuracy in our estimate of the result in this respect, to exclude all those cases in which any anodynes were used. This would, however, under the circumstances, reduce the number of our cases to a very small figure, and yet even with this reduction the evidence would be positive of a favorable effect. But in all fairness such a wholesale exclusion of cases could not be demanded, for in the majority where anodynes were administered, sufficient time had previously elapsed to show whether the earth was going to provoke pain or act injuriously in this

respect; and in some, where the anodyne was given earlier, we had results that could scarcely be set down to the amount of anodyne given. Thus, in Case XII, the anodyne, $\frac{1}{40}$th of atropia was given but once, and then immediately after the first dressing of the stump was made. But this patient was always free from pain, and even the night after his operation he felt so well that he stole out after bedtime to smoke his pipe in the yard. But absence of pain has characterized all kinds of wounds among these cases, whether great or small, under the dressing, save where secondary hemorrhage had taken place, and was indicated by a "burning pain."

In burns or scalds of the first degree, in erythematous inflammations, in ulcers where the pain was in the superficies, and there was no periosteal complication or constitutional taint, we had always a distinct or marked abatement of suffering following the earth's application, and the relief continued even where there was an abundant discharge of pus as long as there was no penning up by the earth. In cases of burns or scalds attended by vesication, or of wounds where a bad article of collodion was used in the dressing, complaints were not rare shortly after the earth was put on, and points were then indicated as the seat of considerable pain, where we found afterwards blisters to have been formed. Now although the effects in all these instances of rupturing the blisters and applying the earth to the denuded surfaces showed clearly for it a sedative power, and although no one could attribute the blistering as an effect to the earth, any more than he could similar sequences after the use of simple cerate, carron oil, or any other soothing application, on a burned, scalded, or artificially blistered surface, to those articles, yet there was a condition of things constantly observed in such cases in these experiments of importance in this connection. I refer to the character of the contents of the blisters so formed. It was that of fibrinous or coagulated lymph. Such lymph is of rare occurrence in similar cases amongst the patients in our hospitals where other dressings are used, and hence I am disposed to attribute its occurrence here to the presence of the earth. Lymph of this kind would seem from my observation to occasion more pain than the serous form when pent up under a vesicated cuticle.

Hence also, I must admit, that the earth in such cases will aggravate the pain unless the cuticle is previously ruptured, and for this very reason I adopted the practice, in cases of burns, of rupturing the blister, and freely denuding their surfaces prior to applying the earth. If, however, it is conceded that the earth has such influence over the character of the lymph exuded from a blistered surface, the concession is a valuable one, as showing the power of the earth to affect in a beneficial manner the process of repair in such injuries, for every one knows that the fibrinous is better than the serous forms of lymph for such purposes. Of this fact we shall take more account when we reach the discussion of the effects of the earth on the healing processes.

In cases where the pains were deep-seated, and in those where it was characteristic of a constitutional taint, no benefit can be claimed to have followed the use of the earth; on the contrary, it may be said that in some of such cases the sufferings were increased; but the number of the last was exceedingly small, for there were only three out of the whole series in which we had proof of an actual aggravation of the pain. This, considering the natural antipathy of the patients to the dressing, and the efforts made to excite opposition to it, must be allowed to be a very small number; as such an objection would have been the very first to be offered had there been any foundation for it.

A remarkable instance of the anodyne effect of the earth on the pain of a superficial burn was in a case which was admitted one afternoon, and died before morning, and in which my clerk therefore had no opportunity to make any memoranda; hence, it is not included in the foregoing histories. I happened, however, to be in the ward shortly after the poor fellow was brought in. When I saw him, he had just had his clothes removed, and was writhing perfectly nude on the bed, as red as a boiled lobster from his head to his feet. I do not think there was a single square inch of his surface that had escaped the influence of the boiling fluid. His condition was the result of his having fallen head over heels into a deep vat of boiling dye an hour or more previous to my seeing him. There was a large basin of the powdered earth standing on the table close by the bed where I found

him, and I quickly began to dust it over him. The relief this afforded the man was as distinctly marked in his face and manner as it was expressed by his tongue; for after I had dusted some over one arm he eagerly held out the rest of his limbs, and after they were covered he turned from side to side to get himself thoroughly enveloped, and whilst this was being accomplished by me he was incessant in his supplications for blessings for the good I was doing. The extent of the burn was, of course, such as to make a fatal result very speedy, but he continued to beg for the earth until the last.

The instantaneous relief which followed the application of the earth in the case of the carbuncle (Case LIII) is also worthy of note. The man's manner, and his exclamation that the pain of the wound I had inflicted had left him after I applied the earth, were most significant.

III. The next effect I wish to direct attention to, as following the topical use of earth, is that which I have designated as *deodorizing*. Now although this word is not to be found in Todd, Walker, Johnson, or even Dunglison, it is not a new one, but is one that expresses more definitely the effect I wish to indicate than that more generally employed, namely, *disinfecting*, for the latter includes more than I think my experiments have in these cases proved for the earth; for it indicates a power to destroy morbific emanations *floating in the air* in addition to that of destroying the offensive odor of substances or vapors with which the article is brought in direct contact. The word *disinfecting* also includes antiseptic powers, which may be independent of that which I now wish to consider in relation to the earth, and properly comes under the next effect I shall have to discuss. Indeed, one of the most instructive cases of the earth's power to destroy by direct contact the offensive odors of a part, illustrates the importance of the choice of the term I have made, for the case (XXI) was the means of contaminating the air of the ward in such a manner that the other cases there suffered after his arm was freely incised in their presence, because no measures were taken to arrest the gaseous emanations which escaped through the opening made in the integuments, and yet at that very time the pus which flowed into the basin from the cut was instantly deprived of its

odor by the earth, and the opportunity was frequently taken at the subsequent dressings of showing how thoroughly the discharges and the parts with which I could bring the earth in contact were deprived of all odor by it. On one occasion (March 10th) I demonstrated this before the class in the amphitheatre, when the following memoranda were made.

March 10th, 1869. Dressed Case XXI, of phlegmonous cellulitis of the forearm, before the class. Prior to removing the dressings applied last night there was no odor perceptible to any of the class who were nearest to the patient. After removing those dressings an odor was emitted from the openings perceptible to even those who were most remote from the case. I then covered the whole forearm with finely powdered clay, thrusting some of it in the openings which existed in the integuments, and after rubbing this powder a few moments over the limb it was all washed off, and that which had been thrown into the openings was removed in a like manner with a stream of clear tepid water. The whole operation occupied but a few minutes of time, and immediately on wiping the limb the patient was sent round the class for a closer examination, and no one could detect the slightest odor about the case.

The fact that offensive odors were to be detected in this case after the removal of the dressings each morning for so many days subsequent to the first use of the earth, was due to our inability to put it in direct contact with the sloughing parts which gave rise to such emanations, for in all the cases where there was no such obstacle there was never any odor to be detected after the dressings were taken off.

The following memoranda furnish a still more striking illustration of this deodorizing effect.

April 16th. At 2 P.M. laid open the scrotum of J. K. (Case LVIII), by an incision, six inches long, to save the tissues from sloughing, and secure, if possible, the vessel which was the source of the sudden increase of the bloody distension. After penetrating the tissues forming the covering of the testicle to the depth of seven-eighths of an inch by measurement, opened the tunic, and a quantity of horribly offensive bloody fluid and clots, sufficient to saturate two pounds of dry clay, was discharged. The fluid escaping into the basin containing the earth,

its actual quantity could not be determined; it was apparently fully a pint. The earth effectually and at once deodorized this fluid; but my hands from manipulating about and exploring the tunic, in turning out the broken-down coagula, &c., became very thoroughly impregnated. Eight vessels had to be secured, and the parts thoroughly explored, so that I spent twenty minutes with my hands in this way. I then filled the sac with dry clayey earth, and washed it out by a stream of cold water. This thoroughly deodorized the scrotum. The cavity was again filled with dry clayey earth as a final dressing, and the patient was returned to his bed. A single washing of my hands in half a gallon of water with one half pound of earth poured into it was sufficient, with the use of a nail-brush, but nothing else like soap, &c., to deodorize them. In fact it has been my constant practice to use this means of cleansing my hands, ever since my first trials with it demonstrated so conclusively the deodorizing property, and my friend, Dr. Thomas H. Andrews, the Assistant Demonstrator of Anatomy, at the Jefferson Medical College, has given it a severe trial in the dissecting-rooms there, at my suggestion. The following are the results of his experience with it.

March 7th, 1871.

MY DEAR DOCTOR:

I take pleasure in informing you that during the past winter, in the dissecting-room of the Jefferson Medical College, I made a thorough trial of the "earth" as a deodorizer in the washing of the hands after dissecting and demonstrating upon the cadaver.

My conclusions are that it is a *complete success*, proving itself decidedly preferable to any of the numerous articles vaunted for the purpose. I have tested it thoroughly. To reiterate, I may say that "earth" stands at the head of the list.

Yours truly,

T. H. ANDREWS,

329 North Eighteenth Street.

Although the facts produced by Mr. Moule may be said to amount to a positive demonstration of a power in the earth which has not been acknowledged heretofore by the educated world, yet they cannot be claimed as a discovery of that power, for it has been recognized from time immemorial, not only by

many practices in civilized life, but by those of man in his wildest state, and of even the brute creation. It has been a custom with the American Indians to bury the opossum meat for a period of days, when they would exhume it free from all its horribly offensive odor, and eat it as a great delicacy. I have been told by those who have imitated this practice that such meat is then most delicate in flavor. The wolf, fox, and such kinds of predatory animals, and even the domesticated dog, evidently do not bury their plunder or half-devoured food in the ground simply to hide it from sight: they could do that more effectually amongst the leaves of a forest; but it would be discovered there by the keen olfactories of those who would rob them of it, for it is more by the scent that they are attracted to a spot for food. It is well known that such animals will pass in close proximity to where meat has been buried, and not discover it, although the ground may furnish evidence of its having been but recently disturbed.

IV. *Inflammations.*—In no instance was there ever any evidence of the earth either provoking or aggravating inflammatory action. In those where such trouble was present, but deep-seated, or dependent upon taint, it had no appreciable effect; but in all the other cases its use was attended by a sedative and beneficial influence in this respect. In some it retarded such action, in others it appeared to arrest it, and in others it actually prevented its development.

Case No. XI is an interesting case as showing the effects of the earth in all these respects. The operation was done on the 17th of February. The wound then made involved over forty square inches, and yet no inflammation appeared on its margins, or was to be detected elsewhere for over four weeks. Subsequently, on the 18th of March, the cicatrix was noticed to be stretching and becoming blue. A few days later it gave way and an abscess was revealed as having formed high up under the upper flap from the presence of some shreds of oakum. Over the development of the abscess there was no evidence of the earth having exerted any influence; but it clearly prevented its exciting any amount of inflammation towards the surface in the surrounding parts. The earth also evidently controlled the subsequent action, some of which was

necessary to effect the second healing. The picture of this case, taken on the tenth day, shows well the absence of all inflammatory irritation.

Case XCI is also a marked one of the power of the earth-dressings. The wound, a lacerated one of the face, was of a most serious character. It not only involved the bones of the nose, necessitating the removal of some of their fragments, but implicated the loose cellular tissues around the eye by infiltration, and yet with all this there were never any signs of inflammation, and we had the most complete and direct union throughout firm enough on the fifth day to admit of the case being pronounced a complete cure.

But the most satisfactory result in this respect was shown in Case LXXIX, an operation for cancer of the breast. The wound here, equally great with that in the case cited above, united throughout, save at one point, in the most direct manner, without the faintest traces of irritation. Even at the one, a minute point, where the union did not take place, the hemorrhage which prevented it may be said to have failed to excite any such action, for although there was discoloration, bogginess, and tenderness from the coagulum, there was never any heat, or other signs of inflammation, nor any suppuration. Many other cases in the series, of a minor character, might be here referred to, but it seems hardly necessary. They all, however, justify the claim for the earth of a power to prevent, and a positively soothing influence over inflammatory action. This I would claim for it, with the recollection and full consideration of the effect from caking pointed out before (I, *b*), for that, as I have mentioned, was a defect in the *method* of using the article, and not necessarily inherent in it as a dressing.

V. *Putrefaction.*—The efficient manner in which the prevention of this process was accomplished, can be judged of by the details of every one of the cases in which we had any reason to anticipate such action here referred to. And as evidence of a negative character, I would draw attention to the difference in results in those cases where I abandoned the earth-dressings for poultices, and thereby got a rapid separation of

the dead parts with greatly increased discharge and offensive odor.

In the case of C. B. (XLIX), where I attempted a Pirigoff through injured tissue, and had the misfortune to wound the posterior tibial, as also the artery running down alongside of the tendo Achillis, which I had to divide on account of the violent action of the muscle, and the posterior flap died from being thus cut off from its chief sources of nourishment, I had the opportunity of watching the effects of the earth in this respect. Although perfectly dead, the flap seemed not at all disposed to separate from the living parts, or in itself to become putrid. In fact, I trimmed away from day to day the portions which were undoubtedly dead, but never could ascertain when it was going to form its line of demarcation until I had resorted to the influence of a fermenting poultice, which caused its putrefaction in a most extraordinary manner.

Thus, on the day before the resort to the poultice, the fact was recorded by my clinical clerk, that the amount of fluid absorbed by the earth, and therefore discharged from the stump, was not over two ounces, by a fair calculation ; whereas, on removing the poultice, after it had been on twenty-four hours, not less than three-fourths of a pint of the most fetid pus ran into the basin placed under the stump in the dressing, and the dead portion was soft, swollen, and excessively putrid. This extraordinary increase of purulent matter continued as long as I used the fermenting poultice, namely, for twenty-four hours after all the slough was got away, when I again resorted to the dry earth dressing. In the next twenty-four hours, the amount of the suppuration was reduced to the minimum of what existed before the resort to fermentation.

I may also refer, under this head, to the case of carbuncles (LIV). There the slough seemed to remain unaltered, and was trimmed away from day to day as it was protruded by the contraction of the living tissues surrounding it.

VI. The last is by no means the least important, or the least significant of the results which I have to record, but it needs the least comment of all to attract attention to its occurrence. The singular rapidity with which healing took place in the

cases of wounds, whether from operations or accidents, of which I have given the details, and similar effects, so noticeable in all the ulcers, except where there was a local cause, or a constitutional one, must have struck the reader, on their perusal, as presenting evidence of a remarkable power in this respect.

ITS MODUS OPERANDI.

The question must naturally present itself to every one, on learning these results following the "use of earth in surgery," how could it exert any influence in their production? This question having occupied some of my attention, and feeling that an intelligent answer to it must materially aid in the removal of some of the objections which will be offered to such use of earth, I now propose to give what data I possess for the purpose; not that I am confident, by so doing, of being able to answer the question as fully and as positively as it is desirable to do; but I believe that an answer can, even now, be made to it with as much distinctness and accuracy as can be made to the same questions concerning the most familiarly known and most generally used of the topical applications in surgery.

On reflecting over this question, the first explanation that will probably suggest itself to the mind of the reader is, that it is merely by purely physical properties, such as excluding the air, absorbing the moisture, and the excess of discharges, and affording uniform compression and support to the parts, that the earth can be of any benefit.

But such an idea is not sustained by the fact that some of each of these effects were obtained under circumstances where the physical actions of the earth were either at a minimum or more or less neutralized or destroyed; as, for instance, in the cases of wounds, &c., about the face and head, there was never a sufficient quantity of earth retained in place to act as either a mechanical support, an excluder of air, or a complete absorber of the discharges; and yet in these cases we had positively beneficial effects from its use. Again, where the earths were applied thoroughly saturated with water we observed good

effects, whereas but trifling if any benefit seemed to accrue where I used them after they had been *thoroughly roasted*, and then applied in a dry state. It is true that the results from the wet earth prove, inasmuch as they were not as satisfactory or decided as those from well-dried but not roasted earths, that the physical condition of the earths had something to do with their effects, but this we had good reason to expect from the fact that porosity, which is increased by dryness, is necessary, as Liebig has shown, for the *most* complete actions of earths in other than a physical manner, and a chemical reason will hereafter be assigned for this difference. Again, the same conclusions are reached by considering the results which have been obtained with the various kinds of earths in connection with what is known as to the differences in their physical properties, as, for instance, by comparing them with what Schübler, who has studied the matter very thoroughly, has shown to be the essential *physical* properties of different kinds of earth. To make this as striking as possible I have prepared the following table from Schübler's researches,* giving the position by numerals of each kind in regard to such properties, and indicating, also in the same way, the proportion of clay element in each, No. 1 being the first, and 11 the last, or representing maximum and minimum relative to the others.

	Specific gravity.	Power to absorb water.	Consistency.	Aptitude to dry.	Hygrometric force.	Power to absorb oxygen.	Power to acquire heat when moist.	Power to acquire heat when dry.	Power to retain heat.	Per cent. of clay.
Silicious sand,	1	11	11	11	11	11	7	4	2	None.
Calcareous sand,	2	9	10	10	10	10	5	7	1	None.
Sandy clay,	8	8	4	8	6	7	8	9	3	60
Stiffish clay,	9	7	3	7	5	5	6	5	6	80
Stiff clay,	10	5	2	5	4	4	4	6	7	90
Pure clay,	11	4	1	4	2	6	2	3	8	100
Chalk,	4	3	9	3	7	8	11	11	10	None.
Humus,	5	1	6	1	1	3	1	1	11	Some trace.
Gypsum,	3	10	8	9	9	9	10	10	4	None.
Garden earth,	7	2	7	2	3	2	3	2	9	52
Arable soil,	6	6	5	6	8	1	9	8	5	51

* Schübler's Annals of French Agriculture, vol. xl, 2d series.

An examination of this table shows that those earths which rank first, as *silicious sand* for specific gravity, *calcareous sand* for retaining heat, *pure clay* for consistency, and *humus* for absorbing moisture, aptitude to dry, hygrometric force, and power when either moist or dry to acquire heat, are none of them, according to our experienee, the best for surgical dressings. *Humus*, which ranks first on this table for *more* physieal properties than any other kind, we have good reason not to rank the highest for our purposes, and so it is with silieious sand, which is at the extreme end 'of the list, as to a greater number of these properties. Nor can we find on searehing this table, that the earth which has these properties most evenly blended, corresponds to the one which we have found to make the best dressing. In fact the most thorough comparison of all these earths, by their physical properties alone and their effeets as dressings, show no correspondenee between sueh properties and effects.

If then, as it would seem, the results are not dependent purely on the physical properties of the earth, are they from any chemical influences which it ean exert? To determine this point we must ascertain what influences of the kind the earth is known to exert, and whether such influenees ean affect the processes in which we have seen the earth act beneficially. Henee we must study the ehemistry both of the earth and of the proeesses which we claim its application to have effected. Earth is in all its varieties a mixture of the most diverse chemical ingredients, and possesses the power, as we believe Liebig was the first clearly to show, of holding in both *chemical* and *physical* combination the elements of a host of substances foreign to it, whenever they are so plaeed as to enable it to exert its influence on them. A speeimen of common surface soil, subjected to merely a qualitative analysis, may be found to eontain siliea, alumina, iron, lime, magnesia, potash, soda, phosphorus, sulphur, carbon, nitrogen, oxygen, hydrogen, besides water, atmospheric air, and the remains of organic matters. The proportions of these and their states of eombination are not always the same. Differences in these respeets, and the aetual absence of some of the components just indicated, not only eonstitute the distinctive features of

various kinds of earth, but are found in earth taken from the *surface* or *beneath* it in the same locality, and the greater the depth to which we penetrate the greater will be those differences. We can thus, sooner or later, reach a point where we will find some of such constituents entirely absent, and others in a minimum proportion, so as to clearly indicate not only their extraneous origin, but by the gradation in which they disappear, also the direction, at least, in which they have come to it. These differences are not simply in the quantities of moisture, atmospheric air, and organic matters, as entities, but in those of the earthy and alkaline salts, and those of the chemical elements, oxygen, hydrogen, nitrogen, &c. Some of the increment of the inorganic elements is clearly traceable to the disintegration of the foreign matters, which have either reached it in a state of solution, or have subsequently passed into such a state through processes going on within the earth itself. Under such circumstances it would seem the soil may abstract some of the constituents of these articles without making any interchange of its own constituents. In this respect the action is like that of *wood* charcoal. "But," as Liebig says, "it goes further, for it is sufficiently powerful to sever the connection between the bases and the mineral acids for which they have greatest affinity, the bases being absorbed by the soil just as though they were not combined with the acids." In this latter property the earth acts, as Liebig has also pointed out, "like *animal* charcoal, which by means of phosphates of the alkaline earths contained in it decomposes many salts that are not affected by charcoal free from such phosphates." Since the time when Baron Liebig first gave such interest to these matters in relation to agriculture, there have been numerous investigations made regarding them, and from amongst them I will specially select for quotation the very elaborate papers on the "Absorbing Powers of Soil," of Mr. T. Way, consulting chemist to the Royal Agricultural Society of England, which are contained in the 11th and 13th volumes of that Society's Journal. In his recapitulations of the principal results of his experiments, Mr. W. says: "It was found that ordinary soils possessed the power of separating from solution in water the different earthy and alkaline sub-

stances presented to them; thus, when solutions of salts of ammonia, of potash, magnesia, &c., were made to filter slowly through a bed of dry soil five or six inches deep, arranged in a flower-pot or other suitable vessel, it was observed that the liquid which first ran through no longer contained any of the ammonia or other salt employed.

"But further, this power of the soil was found not to extend to the whole salt of ammonia, or potash, &c., but only to the alkali itself. If, for instance, sulphate of ammonia were the compound used in the experiments, the ammonia would be removed from solution, but the filtered liquid would contain sulphuric acid in abundance—not in the free or uncombined form, but united to lime; instead of sulphate of ammonia, we should find, after the experiment, sulphate of lime in the solution, and this result was obtained whatever the acid of the salt experimented on might be." "When muriates or nitrates were operated upon, muriate or nitrate of lime was found in the place of the former salts."

"It was found that the process of filtration was by no means necessary; by the mere mixing of an alkaline solution with a proper quantity of soil, as by shaking them together in a bottle and allowing the soil to subside, the same result was obtained; the action, therefore, was in no way referable to any physical law brought into operation by the process of filtration.

"Again, it was found that the combination between the soil and the alkaline substance was rapid, if not instantaneous, partaking, therefore, of the nature of the ordinary union between an acid and alkali. In the course of these experiments several different soils were operated upon, and it was found that all soils capable of profitable cultivation possessed the property in question in a greater or less degree. It was shown that the power to absorb alkaline substances did not exist in sand; that the organic matters of the soil had nothing to do with it; that the addition of carbonate of lime to a soil did not increase its absorptive power for these salts; and, indeed, that a soil in which carbonate of lime did not occur, might still possess in a high degree the power of removing ammonia or potash from solution, and it was evident that the active in-

gredient in all these cases was clay.* Further trials proved that the stiffest and most tenacious clays, taken from considerable depths, which had never since their deposition been exposed to atmospheric influences, and which also were absolutely free from organic matter, or carbonate of lime, that these pure clays possessed to the fullest extent the absorptive property."

Some of the clay which Mr. Way used in his experiments was sent to him in masses, taken from a depth of nearly twenty feet from the surface, and furnished in itself an instance of the tendency of clay to unite with ammonia; for "a small portion taken from the centre of a mass (and which had consequently no opportunity of absorbing any gaseous substance from the air), was found to give off abundance of ammonia when heated in a tube."

"There were (he says) two possible ways in which the clay might have acquired this ammonia; either, in the course of ages, water, penetrating to the depth of twenty feet through a most impervious stratum of clay, may have carried with it some portion of ammonia, or the clay must have absorbed ammonia from the water in which, at a remote geological period, it was suspended before deposition in its present place. The first of these suppositions is improbable, on account of the almost physical impossibility of water percolating the mass, and because, as the clay is not nearly saturated with ammonia, it would not have been likely to have reached these inferior layers at all."

There is little doubt, therefore, that the ammonia found in the clay was derived from organic bodies decaying in the very water from which the clay was deposited. We could hardly have a more striking instance of its power of absorption and *retention* of ammonia in despite of water, to the action of which it must have been at that time exposed for a very lengthened period. The results of Experiments 8, 9, and 10 of Prof. Way, in which he attempted to force, by means of a syringe, a solution of ammonia through some powdered clay; and of Ex-

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* Berthier, long since, showed that clay is a hydrated silicate of alumina.

periment 11, where the earth was more thoroughly dried and more finely sifted, "are interesting as indicating, as he observes, the rapidity with which the absorption of ammonia by the soil takes place; a circumstance which leads us to liken the action to chemical combinations of the most powerful kinds, such as those of mineral acids for alkalies or alkaline earths. It also appears, that in conducting experiments on this subject there is no occasion for any *prolonged* action of the soil upon the solution, provided that the perfect contact of the two is attained."*

Mr. Way, in the following fifty pages of the Agricultural Journal, details, in some ninety experiments, his trials with various kinds of soils, and various kinds of alkaline and saline solutions. Thus he tested the property in sand, clay, loam, pure sand, sandy soil, pure clay, burnt and unburnt, and clayey soils, and he used solutions of the muriate, carbonate, sulphate, nitrate, phosphate of ammonia, and similar salts of lime, potassa, soda, and the free acids, and putrid urine, and his conclusions of the chemical action of the earth in the premises, are most accurate and convincing.

To all this evidence of *chemical* power, not only possessed by earths, but actually exerted by them, I would add that afforded by my cases themselves, and by experiments which I have made in connection with them.

I would here first recall the fact constantly observed, and on all occasions where I have tested the point, and they have been numerous, viz., a power in earth (yellow clayey earth), to completely neutralize the reaction which the surfaces of wounds and ulcers gave immediately before the earth was applied. This was not confined to rendering neutral the alkaline state which such surfaces usually presented, for I obtained the same neutralizing effects where the reaction was originally decidedly acid. The earth, after having been long enough in contact with the ulcerated surfaces to become saturated by the fluid, ceased to have such effects on the discharges from the part.

Furthermore, I. I have found that

* The italicizing in these quotations is Mr. Way's.

(*a.*) Litmus paper, reddened by acid urine to a deep tint, has its color restored by laying it whilst wet on dry earth.

(*b.*) Litmus paper, which retained its color when put in urine some days old (which gave originally strong acid reaction), became darkly reddened when it was buried in the earth.

(*c.*) Turmeric paper made deep brown by contact with old bloody urine, which was strongly ammoniacal at the time, was restored to the natural yellow hue by being laid on some of this earth.

(*d.*) Litmus paper reddened by dilute acid, and turmeric discolored by fumes of ammonia, gave the same result, when buried in the earth, as those designated in (*a*) and (*c*).

(*e.*) Litmus paper wet with distilled water, but unaltered in the air, became slightly reddened by contact with some freshly pulverized yellow clay; it however recovered its color almost perfectly by being allowed to *dry* on the earth.

(*f.*) Dry litmus paper retained its color perfectly when buried ten days in a box, filled with well-dried clayey earth, and tightly covered. The same results followed when the box was left uncovered in my office during the equinoctial storm of September.

II. Qualitative analysis of earth before and after it had been used in cases of extensive suppuration, which were made by my friend and former pupil, Dr. John Newton, at the High School, where he occupied the position of Assistant Professor of Chemistry, showed that such earths, originally devoid of salts of ammonia, had become richly charged with them after twenty-four hours of such use.

Enough has already been adduced to satisfy, I think, any one of the earth's power to act *chemically*, and we may without any more delay on that point, pass to the consideration of whether it does so specially in the cases where we have had good results after its use. To do this properly we must, however, have a sufficiently clear understanding of the nature of the processes involved in each effect heretofore indicated as will enable us to determine with certainty that they are amenable to such kinds of action as we have now seen the earth can exert.

The changes which take place in our tissues when undergo-

ing either decay or putrefaction will be admitted by all to be essentially chemical ones. These processes, with odor as their product, are not only free from all the influences of *vital action*, but are essentially the results of its absence, and hence the three may be better studied first than any of the others in which we claim an influence for the earth, but in which vital action is supposed to have full force.

"The tendency of the tissues of our bodies, when devoid of *vitality* is to *spontaneous decomposition*. This consists either in a *slow combustion* of the organic matter by the surrounding air, or in a new arrangement of the elements of such matter in different proportions, and the consequent formation of new products. The former process, that of slow combustion, is called *eremacausis* or *decay;* the latter, *fermentation* or *putrefaction* in *the widest sense*. When the latter or inward decomposition is accompanied by an offensive odor, which is particularly the case with nitrogen and sulphur compounds, it is denoted by the special term putrefaction; in the contrary case, it is called fermentation. Both processes, viz., that of slow combustion (or decay), and that of inward decomposition (or putrefaction in its general sense), generally take place simultaneously. An abundant supply of air is favorable to the former (decay), a scanty supply to the latter (putrefaction); hence decay takes place most on the surface." (Gmelin.)

The authority from whom we have just been quoting, says: "Simple oxidation of organic substances in the air, such as the conversion of aldehyde into acetic acid, or the resinizing of volatile oils by exposure to the air, must not be regarded as instances of eremacausis."

In decay the carbon and hydrogen of the compound are converted by combustion into carbonic acid and water, and the nitrogen either escapes in the form of gas, or is converted into nitrous and nitric acid. As in this process the compound continually loses more and more carbon and hydrogen, it might be supposed that the residue would become continually richer in oxygen. This, however, is not always the case. For while the carbon of the compound is combining with the oxygen of the air, and forming carbonic acid, it is possible that a large portion of the oxygen contained in the compound may

go off with hydrogen in the form of water, so that the residue may become richer in carbon than the original compound.

"A decaying substance may bring other bodies into the state of slow combustion. Decaying organic substances, surrounded with a mixture of hydrogen gas and air, or oxygen, cause it to condense in the form of water." (Saussure.) "Decaying substances in contact with water and alcohol, cause the latter substance to oxidize and form acetic acid." (Liebig.) "Decay is accompanied by *evolution of heat*, which in most cases, in consequence of the slowness with which it takes place, and the cooling produced by surrounding objects, amounts to only a few degrees; but when large masses are concerned, may, under favorable circumstances, rise to such a height as to induce rapid combustion (as decaying of manure)."

With regard to the behavior of nitrogen in decay, Gmelin observes:

1. The nitrogen of an organic compound escapes in the form of gas, especially if the air has free access, or the compound is exposed to the sun, and no salifiable bases are present.

2. It is converted into nitric acid, especially with free access of air, in the shade and in the presence of a salifiable base, which favors the formation of nitric acid by predisposing affinity. The base may be potash, soda, lime, or magnesia, in combination with carbonic acid, or a vegetable acid; for the carbonic acid escapes as fast as the nitric acid comes in contact with the potash, &c., and the organic acid is destroyed by the slow combustion. According to Vaudin's experiments, the formation of nitric acid appears to be preceded by that of nitrous acid.

3. The nitrogen of the compound unites with its hydrogen and forms ammonia, which generally escapes as carbonate. This ammonia is not so much a product of decay as of fermentation.

4. Now, azotized organic compounds appear, under certain circumstances, to absorb nitrogen from the air during decay, either in the form of ammonia or of nitrous acid. The juice of fresh plants never gives off nitrous vapors when treated with tartaric acid. The formation of nitrous acid in decaying

vegetable matters takes place much more quickly in damp than in dry air. The air yields both nitrogen and oxygen for the formation of nitrous acid. (Vaudin.) Saussure rightly observes that "the nitrogen might also be derived from an azotized compound in the plant." (Gmelin.) "When the air has but partial access, part of the hydrogen of the organic compound appears to combine with the nitrogen of the air to form ammonia, which can then supply the requisite quantity of nitrogen to the fungi which grow upon these putrefying substances." (Ibid.)

As to the process which, following Liebig's distinction we must designate as eremacausis, Boussingault says: Organic substances, moistened and exposed to the air under a temperature, the minimum of which (I believe after several experiments) may be fixed at 48° or 50° Fah., seize upon the oxygen and absorb it, in part, in order to form water with their hydrogen and carbonic acid with their carbon. When these substances are accumulated in a mass sufficiently great, and the heat produced is not rapidly dissipated, the temperature rises, and promotes reaction to such a degree as to produce active burning, or conflagration, in place of the slow combustion manifested at first. It is not very unusual to see hay which has been gathered in too damp a condition, take fire in the stack, and the high temperature acquired by wet rags placed in the fermenting vats of paper-mills, and the copious production of carbonic acid, which results show that we are right in assimilating this kind of action to the phenomenon of combustion. This sluggish combustion is not peculiar to azotized organic substances; it takes place equally in those destitute of azote. The alteration of organic matters, the combustion which goes on at a low temperature by the action of the air, differs in its results from the decomposition which is effected in the midst of a liquid mass. We have seen, for example, that gluten fermenting under water disengages hydrogen gas. Now, Berthollet has established, and Saussure has confirmed his observations, that an azotized body in putrefying, the whole of whose parts are in contact with the air, never contributes either hydrogen gas or azote to the confined atmosphere in which it is placed; and, on the other hand, Saussure has shown that

organic substances which do not emit hydrogen gas during their spontaneous decomposition in a medium void of oxygen, do not alter the volume of an atmosphere of which this gas forms a part. On the contrary, these substances condense oxygen as soon as they attain the stage of their alteration in which they give out hydrogen.

"In pursuing with persevering sagacity the study of putrefaction, M. Saussure discovered the cause of this condensation. It consists in the fact, that an organic substance in course of spontaneous decomposition, acts in some respects like the platina sponge placed in a mixture of oxygen and hydrogen gas; we know that platina recently heated and introduced into a mixture of these two gases, determines their union in the proportions required to produce water. Now, by substituting for the metal some moistened seeds, previously deprived of their germinating faculty, the same effect is produced; the two gases combine until one of the two entirely disappears. When this combustion of hydrogen, proceeding from the decomposition of organic substances, takes place in the body of the atmosphere which contains azote, it is possible that a minute quantity of ammonia may be produced together with water, nor is it going too far to suppose that manures very slightly azotized take up azote from the atmosphere during their fermentation." (Boussingault.)

"The conditions which determine the commencement of decay are of various kinds. Many organic substances, particularly such as are mixtures of several more simple matters, oxidize in the air when simply moistened with water; others not until they are subjected to the action of alkalies, but the greatest part of them undergo this state of slow combustion or oxidation when brought in contact with other decaying matters. The eremacausis or decay of an organic matter is retarded or completely arrested by all those substances which prevent fermentation or putrefaction. Mineral acids, salts of mercury, aromatic substances, empyreumatic oils, and oil of turpentine, possess a similar action in this respect. The latter substances have the same effect on decaying bodies as on phosphuretted hydrogen, the spontaneous inflammability of which they destroy." (Boussingault.)

"The contact of ammonia and alkalies in general, may be mentioned amongst the conditions which determine the commencement of eremacausis for their presence causes many substances to absorb oxygen, and to decay, in which neither oxygen nor alkalies alone produce the change." (Ibid.)

"The most general condition for the production of eremacausis in organic matter is contact with a body already in the state of eremacausis or putrefaction. We have here an instance of true contagion, for the communication of the state of combustion is in reality the effect of the contact." (Ibid.)

"When a moist azotized animal matter is exposed to the action of the air, ammonia is always liberated, nitric acid is never formed.

"But when alkalies or alkaline bases are present, a union of oxygen with the nitrogen takes place under the same circumstances, and nitrates are formed, together with other products of oxidation; the combination of oxygen with nitrogen occurs rarely during the combustion of compounds of the latter element with carbon, but nitric acid is always a product when ammonia is present in the substance exposed to oxidation." (Ibid.)

The cause wherefore the nitrogen in ammonia exhibits such a strong disposition to become converted into nitric acid, is undoubtedly that the two products which are the result of the oxidation of the constituents of ammonia possess the power of uniting with one another. Now this is not the case in the combustion of compounds of carbon and nitrogen; here one of the products is carbonic acid, which on account of its gaseous form, must oppose the combination of the oxygen and nitrogen, by preventing their mutual contact, while the superior affinity of its carbon for the oxygen during the act of its formation will aid this effect.

"When sufficient access of air is admitted during the combustion of ammonia, water is formed as well as nitric acid, and both of these bodies combine together. The presence of water may, indeed, be considered as one of the conditions essential to nitrification, since nitric acid cannot exist without it."

"Putrefaction depends, like dry distillation, on an alteration of arrangement of the elements already contained in the organic compound, but the elements of water are likewise concerned in the action; in fact without their presence no fermentation can take place. For its commencement, free access of air is often necessary, but when once set up it can go on without contact of air." (Gay Lussac.)

"In this process organic compounds of a higher order are resolved sometimes into lower organic compounds, sometimes into inorganic compounds, as carbonic acid water, ammonia, or sulphuretted hydrogen; sometimes into simple substances, as hydrogen and nitrogen gases. The affinities which tend towards the formation of organic compounds of a lower order, or of inorganic products, are doubtless stronger than those by which the original substance is held together, and this circumstance is doubtless connected with the evolution of heat which accompanies fermentation" (Gmelin.)

"The organized substances which change the most rapidly, are precisely those into which azote (nitrogen) enters as a constituent principle. Left to themselves, whether in solution or merely moistened, these substances exhibit all the characteristic signs of putrefaction; they exhale an insupportable odor; and the result of their total and complete decomposition is finally the production of ammoniacal salts. The water wherein the phenomenon is accomplished facilitates it, not only by weakening cohesion, and enabling the molecules to move more fully, but it assists also by the very affinity which each of its own principles bear to the elements of the substance subjected to the putrescent fermentation." (Bousssingault.)

"Proust observed that during the decomposition of gluten, immersed in water, a mixture of carbonic acid and of pure hydrogen gas is disengaged, a phenomenon which he explains by the decomposition of the water; at the same time are produced ammoniacal salts, amongst which are acetates and lactates, whose acids are generated by the very act of fermentation. As a striking example of the agency of water in the transit of azote into the ammoniacal state in a quaternary compound, Boussingault cites the putrefaction of urea."

Its composition, according to Dumas, is:

Carbon,	20.0
Hydrogen,	6 6
Oxygen,	26 7
Nitrogen,	46.7
	100 0

The animal substances dissolved in urine, as the mucus of the bladder, &c., undergo on contact with the air a modification which causes them to act upon urea like ferments. By their influence the elements of water react upon the substance, and transform it into carbonate of ammonia. Carbonate of ammonia is composed of—

$$\text{Carbonic acid, 56.41, containing} \begin{cases} \text{C } 15.39 \\ \text{O } 41.02 \end{cases}$$

and

$$\text{Ammonia, 43.59, containing} \begin{cases} \text{H } 7.69 \\ \text{N } 35.90 \end{cases}$$

But 100 of urea have been found to produce by fermentation 130 of carbonate of ammonia.

	C.	H.	O.	N.
Previous to fermentation 100 of urea contains:	20.00	6.60	26.70	46 7
After fermentation the 130 of carbonate of ammonia (which is the result) contains:	20.00	10.00	53.30	46 7
Difference,	00.00	3.40	26.60	00 0

So that during its transformation the urea has gained 3.4 of hydrogen and 26.6 of oxygen. In water the hydrogen is to the oxygen as 1 to 8. Now it is precisely in this proportion that hydrogen and oxygen are found to be acquired by the urea in passing into the state of carbonate of ammonia, whence it follows that the elements of water are fixed in the process.

"The putrefaction of azotized substances is far from always presenting results equally precise. Most frequently in decomposing they pass through a series of changes still very obscure before they attain their ultimate limit, viz., the production of ammoniacal salts.

"One of the most striking characteristics, at least that which

is most readily remarked, is the fetid odor which animal substances exhale during putrefaction. It is not always the smell of ammonia which predominates, that of sulphuretted hydrogen gas is often very strong, yet that is not the emanation which is most offensive; miasmata and nauseous principles are also developed which seem to be the changed matter itself, carried away by the gases that are disengaged.

"Sulphur, like phosphorus, is almost always a constituent of organic bodies; its minute proportion, however, would be insufficient to give out the hepatic odor so intense as we often find it during putrefaction. The production of sulphuretted hydrogen is connected with the very curious fact, first appreciated by M. O. Henri, that sulphates dissolved in a medium impregnated with azotized matter in decomposition, do themselves undergo an actual reduction, pass into the state of sulphurets, and immediately give out sulphuretted hydrogen, either by the action of the carbonic acid of the atmosphere, or by that which is formed during the putrefaction of the organic matter.

"The causes of the distinction of sulphates under such circumstances is easily understood. During the decomposition of organized substances the carbon belonging to them forms carbonic acid gas, by combining both with the oxygen of the substances themselves and with the oxygen of the water. It is probable that the oxygen of the sulphuric acid contributes equally to this formation, and that the sulphur is liberated.

"The hydrogen of the decomposed water, as well as that of the solid matter in contact with sulphur in the nascent state, combines with it to form sulphuretted hydrogen, which straightway reacts upon the base of the sulphate, producing from it, as we know, water and a metallic sulphuret. This sulphuret being unable to exist when exposed to the continued disengagement of carbonic acid gas, which takes place in the centre of the mass in putrefaction, yields, as a definite result, a carbonate on the one part, and sulphuretted hydrogen on the other." (Boussingault.)

To this exposition of the phenomena and rationale of the processes I would add the following details, relating to the processes in the substances in which we have to consider them:

"Freshly-drawn blood placed together with air over mercury at ordinary temperature does not act upon the air in the first twelve hours. Subsequently the quantity of gas diminished, because the carbonic acid gas formed from the oxygen is absorbed; but when the blood becomes saturated with carbonic acid, ammoniacal putrefaction takes place, and the volume of gas increases in consequence of the evolution of carbonic acid. Fibrin of blood similarly treated converts all the oxygen of the air in twenty-four hours into carbonic acid, a small portion of which is absorbed by the decomposed mass; afterwards the volume of gas continually increases in consequence of the evolution of carbonic acid." (J. Davy.)

"Of the more solid parts of animals, those (as far as we are now specially interested) which putrefy most quickly in the fresh state, are the muscles and glands; they give off carbonic acid even in the first few hours, and increase the volume of gas in twenty-four hours. Then follow the skin, the periosteum, veins, and arteries, which produce carbonic acid in twenty-four hours, and increase the volume of the gas in an interval varying from forty-eight to seventy-two hours. Putrefaction takes place still more slowly in tendons, intervertebral substances, cartilage, and bones." (J. Davy.)

"When putrefaction has once commenced, it goes on even after the oxygen has been completely absorbed, carbonic acid and ammonia being disengaged, and sometimes also a small quantity of sulphuretted hydrogen, or (especially in the case of muscles) of marsh gas." (J. Davy.)

"During this putrefaction heat is evolved; and in the case of the more quickly putrefying animal matters, such as blood, fibrin, the muscles, tendons, &c., the temperature rises from 1° to 6°. In slowly putrefying substances, the evolution of heat is not perceptible in consequence of the slowness of the action, but it undoubtedly takes place. Animal substances are converted by putrefaction, with formation of carbonic acid and ammonia, into a semifluid mass, which serves as food for the larvæ of flies, and is gradually resolved into ammonia and extractive matter." (J. Davy.)

"In dilute aqueous solutions of substances which are in-

clined to putrefy, innumerable infusoria are quickly formed." (G. Gmelin.)

"Muscular flesh keeps tolerably well at a few degrees above 0°, but at 15° Cent. it passes into slow, and at 25° into rapid putrefaction. It then becomes softer, yields a watery liquid, gives off an almost intolerable ammoniacal odor, which gradually diminishes, and at length ceases altogether, and is converted, first into a thin pap, and afterwards into a nearly inodorous, brown, fusible mass (mould), which weighs but very little." (Fourcroy, Priestley, Pringle, Creil.)

"The greenish color of meat, at the commencement of putrefaction, is perhaps due to the presence of sulphite of iron." (Gmelin.)

"Fresh beef inclosed in oxygen gas exhibits, for the first few days, a finer red color than before, but afterwards becomes paler and moist, exudes transparent drops, which afterwards turn milky, and becomes putrid in eleven days; if left for fifty-one days, it deliquesces and emits an insupportable odor. A great part of the oxygen gas is found to be converted into carbonic acid. In hydrogen gas meat acquires a light brown color, becomes somewhat drier and more solid, and after eleven days is not at all putrid, but has a scarcely perceptible sour smell; if afterwards exposed to the air, it dries up to a hard mass without putrefying. In another experiment the meat, even after fifty-four days, exhibited the appearance of fresh meat, but stank horribly, though its odor was different from that of meat putrefying in oxygen gas; the hydrogen was afterwards found to be mixed with carbonic acid. In carbonic acid gas, meat appears brown or red at first, but afterwards becomes paler. After eleven days it resembles boiled meat in color, and is very soft, but not sticky, its odor is very faintly acid, and on exposure to the air it does not putrefy, but dries up. After fifty-one days' immersion in carbonic acid gas, it exhibits the color and consistence of boiled meat, and is not at all putrid. In *sulphurous acid gas* meat immediately loses its color; after seventy-six days it becomes much harder and drier than fresh meat, smells of sulphurous acid, and on exposure to the air dries up in four days without putrefying. In *gaseous fluoride of silicium* meat exhibits nearly the same characters. In *nitric*

oxide gas it immediately acquires a brighter red color, and if taken out after eleven days exhibits a fine red color, is nearly inodorous, acquires a dark color on exposure to the air, and dries up quickly. A piece of meat left in this gas for one hundred and thirty-four days appears bright red and solid, and smells somewhat of nitric acid. In *ammoniacal gas*, meat acquires a brighter red color, which it retains, if kept in the gas for seventy-six days. When taken out, it is soft, inodorous, and does not putrefy on exposure to the air, but dries up to a brown, shining mass." (Hildebrant.) Similar experiments have been made by Priestley, Brugnatelli, and Boekmann.

"The prominent part assigned by Boussingault, in his account of the Chemistry of Putrefaction, to oxygen, is conceded to it by all chemists, and even by those who believe in the fungous or animalcular nature of the process. Thus, Schrœder and Von Dusch, who were amongst the earliest to believe in such an origin for the process, and that such organisms were derived from the atmosphere, state in their account of experiments made on the filtration of the air through cotton, that it appears then settled, that there is a spontaneous decomposition of organic substances, as the putrefaction of meat without water, of the casein of milk as well as the transformation of the sugar of milk in the milk into lactic acid, that requires for its commencement only the oxygen of the air, and that there are other phenomena of fermentation and putrefaction which are improperly placed in the same category, viz., the fermentation of malt wort, and the putrefaction of meat under broth, which require for their commencement, besides the oxygen, some unknown admixture in the atmospheric air, which, according to Schwann's experiments, is destroyed by heat, and according to ours removed by filtration through cotton." (Liebig's Annalen, Feb., 1854.)

Bence Jones tells us (p. 227) that, "generally speaking, fermentation may be considered as a peculiar oxidation, in which carbonic acid and water and heat are produced; but instead of a dual action of oxygen on organic substances, fermentation consists in the mutual action of three substances, namely: oxygen, the organic matter, and the ferment. These three substances interfere not only in the chemical actions of oxy-

gen, but also in those of nutrition, so that a long list of substances might be formed, beginning with the spermatozoon, and passing through torula until we come to pepsin, which are capable in health or in disease of so increasing or altering the chemical actions of oxidation and nutrition in the body, that quantitative or qualitative results are obtained which would not have been reached by the ordinary actions without the intervention of the third substance."

Singular as have been the discoveries of the presence of animal matters, bacteria or fungi of microscopic characters in our air, it is yet far from being proved that *they* are the *cause* rather than the *effect* or concomitant of decay and putrefaction, and the animalcular or fungous theory of disease and morbid processes needs further support than any yet brought forward to secure its general acceptance. The curious experiment of Schrœder and Von Dusch, whereby they were able to preserve meat broth from putrefaction by corking it up when boiling with simply some cotton wadding, is a very strong point, and has been used with great effect by the advocates of such things, but they forget that Schrœder and Von Dusch distinctly admit that the *same thing* arrested by the cotton is only required for the putrefaction of meat under broth, "and the fermentation of malt wort," and that the oxygen of the air which is not arrested by the cotton is sufficient for the decomposition of meat without water, and of the casein of milk. When the processes of decay and putrefaction set in, in our surgical cases, the condition of the part is usually very far from that of "meat under broth," or of the "mash" in the brewer's vat, unless it has been covered by a water-dressing, or a poultice fermenting or fermentable in its nature. Such applications then furnish materials very often, but this does not prove the animalcular or fungous origin of the process, nor does it follow because low forms of organism are to be found in the tissues affected by these processes that such are the cause of the process, any more than the frequent pulse can be called the cause of fever, or of a diseased heart. In the decomposition of the tissues, as it has been long admitted that a new arrangement of the elements of such takes place, we have the consequent formation of new products, and as the physicist claims, the low organiza-

tions as the results of such formation. But it is not necessary for us to enter into the discussion of spontaneous generation to sustain a non-organic origin or cause for the processes of decay and putrefaction as we have to deal with them. For although we are considering them under circumstances where it is quite possible for such organisms to reach the part from without, it is begging the question for the advocates of such a cause to say that they are derived from the air only, and that the results of the exclusion of the air shows them to be the cause of such processes. It is for them to show that the appearance of these organisms precedes all the phenomena and products of the processes, and this they have failed to do.

The following, from the British Medical Journal, October 15th, 1870, p. 407, has a direct bearing on this subject.

THE SUCCESS OF THE ANTISEPTIC TREATMENT OF WOUNDS.

EXPLAINED WITHOUT REFERENCE TO GERMS.

BY R. T. MANSON, L.R C.P , ED.

Having adopted and found good reason for continuing to use what is known as Prof. Lister's Treatment of Wounds, I may go on to state that I entertain serious doubts as to the soundness of the theory upon which it is based. These doubts arose from some cases of wounds in which the "germs" had full access for some time, in which no germicide was used to the surface of the wound, and yet in which no pus was formed.

It is difficult to resist the conviction that the ubiquitous, impalpable germ, as difficult to capture as the fairies of old, has like the "good folks" been debited with much mischief of which it is innocent. Prof. Lister's theory is so well known that it is unnecessary to recapitulate it. The theory which I propose is that the success of Prof. Lister's treatment is due to the carbolic acid producing on the surface of a wound a stratum of coagulum, which prohibits the germinal cells below from the deleterious action of the oxygen of the atmosphere, just as the epidermis protects the true skin; and secondly, to the production of an atmosphere or retention of an atmosphere of carbonic acid in and around the wound, &c.

Hoppe-Seyler has recently made a most important contribution to our knowledge of the processes of putrefaction and disinfection. (Chem. Unters., 1871, pp. 557–581.) His results show that the fluids underwent putrefaction, whether living organisms were present or not, and that these exercised apparently no influence on the rapidity of the process, but that this was solely dependent on temperature. The action of carbolic acid on the lower organisms and on ferments was demonstrated to be analogous to that of heat. It required over one per cent. of the acid to stop the putrefaction of albumen. Disinfectants, he thinks, act by forming precipitates with ferments, by preventing the generation of heat by the splitting up of complex into simpler substances; in other words, by preventing oxidation.

From all the facts developed before and since the times of Schrœder and Von Dusch, it cannot be denied that the essentials for the production of putrefaction are a certain amount of warmth, moisture, and contact with the atmosphere, and that when once established it can maintain itself even after the last has been thoroughly excluded.

In our treatment of the process the point essential for us to determine is the conditions of its maintenance; for it avails us but little to find out what its true nature is, unless by so doing we can discover the means of its destruction, and in the absence of positive knowledge on the latter point, which must be fairly conceded, we need not occupy any further time in considering what has been set forth as to the organic or inorganic nature of the process, but direct our attention to the details of the physico-chemical conditions by which it is maintained. Now, although the access of air is only necessary for the inception of putrefaction, and the oxygen so furnished may or may not be essential for its provocation, we have had already the most indubitable evidence that when the process has once set in the greed for this element is such as not only to rob the air so furnished of it, but to take it from its association with elements having so strong an affinity as sulphur in its combination as sulphuric acid in the sulphates. Here we have a satisfactory explanation of the secondary products, such as ammonia, sulphuretted and phosphuretted hydrogen, &c. In the first in-

stance the hydrogen of the water in either the tissues or the air itself, and the nitrogen of the air, or of the breaking down nitrogenized material, being liberated by the removal of their oxygen, combine and form ammonia; and in the latter instances the sulphates and phosphates, from the same sources as the hydrogen, are reduced by this same greed for oxygen through their process of combustion in order to sustain itself, and we have as a consequence sulphuretted and phosphuretted hydrogen.

The adoption of such a view without qualification or explanation could readily lead to the inference that putrefaction is simply a process of combustion, and should therefore be most active in, if not confined to, substances specially rich in carbon, whereas we have seen that it is the nitrogenized substances, and not those richest in carbon, which possess the faculty of undergoing this process to the greatest degree when in the presence of heat and moisture. This would seem "to depend upon the tendency which azote has to unite with hydrogen in order to form ammonia." (Boussingault.)

Indeed, this same authority, from whom we have quoted so largely to show the part taken by oxygen in *exciting* putrefaction, declares that this tendency of nitrogen to unite with hydrogen is, perhaps, the determining cause of the phenomena of fermentation, taken in the most general acceptation of the term. Organic bodies void of azote decompose less easily, and the kind of alteration which they undergo from the action of water and air differs in many respects from the putrefaction of azotized matter. Of this the difficulty of effecting the fermentation of vegetable substances is a proof. "The refuse of plants the most amply endowed with azote, such as cabbage, beetroot, beans, &c., are certainly those which are susceptible of the most rapid and complete putrid fermentation."

These remarks in reference to nitrogen and hydrogen it must be understood are not, however, to detract from the part taken by oxygen in the process, but to prevent the assumption that it (oxygen) is the only element actively engaged in the process, and to fix in mind the fact that both nitrogen and hydrogen also take an active part in it.

"Recalling Gmelin's and Henri's observations, there can be

no doubt that the production of ammonia, and the offensive ammoniacal and other hydrogen compounds, specially noticeable in the putrefaction of animal (nitrogenized) tissues where there is a limited access of air, are the sequence of the abstraction of the oxygen with which they, the hydrogen, nitrogen, sulphur, and phosphorus, were previously combined in the tissue; they being thereby set at liberty are able to exercise their affinity for each other, and do so with great promptness. So also in the opposite state, where there is an abundant supply of air, or, still better, of oxygen, and a salifiable base close at hand, we have the nitrogen converted into nitric acid, and the hydrogen into water, and the two either fixed by the formation of a solution of the saline, and if some of the hydrogen should combine with nitrogen to form ammonia, it would in turn combine with the carbonic acid generated by the combustion of the carbon. In this way, by a free supply of oxygen, one of the products of putrefaction, the stench so characteristic of it in its virulent form, may readily be prevented without the process, however, being in any way arrested or even interfered with. Hence an efficient disinfectant or deodorizer is not necessarily an antiputrescent. Most, indeed, of our disinfectants owe their power to the fact that they are active or energetic oxidizers. Such is the case, for instance, with permanganate of potash, and every one knows, who has had any experience with its use, that it has no power whatever over the process which has given rise to the fetor it so promptly destroys. An oxidizer is, therefore, not an antiputrescent, but, on the contrary, a powerful aider to the process of putrefaction, hastening it through its various stages with a rapidity which it could not have alone, or by the mere addition of atmospheric air. The failure as disinfectants of some such agents is due to the fact that they do not fix the ammonia and its derivatives, and by others, as the mineral acids, to the fact that the ammonia and its derivatives are alone acted on favorably, and hence through the liberation of sulphuretted hydrogen the stench is aggravated." (Dr. Heppe.)

The action of heat in effecting decomposition is due in part to "the affinity of the oxygen for the hydrogen and the carbon (tending to form water, carbonic oxide, and carbonic

acid), being greater at high temperatures than that by which the elements in the organic compound are held together. Hence those compounds which contain most oxygen decompose at much lower temperatures than those which contain little or none."

"At high temperatures decomposition is facilitated by the affinity of heat, for those elements which have a great tendency to assume the gaseous form, hence part of the hydrogen and nitrogen are given off in the state of gas, the quantity thus evolved increasing with the temperature; the hydrocarbon formed at a moderate heat may be resolved at higher temperatures into hydrogen gas and sooty carbon. The heat may also induce a disposition for the formation of volatile organic compounds, which, when once produced, pass over and are thus withdrawn (in dry distillation), from the decomposing action of a stronger heat." (Gmelin, vol. i, p. 78.)

Baron Liebig, in his most recent exposition of the Chemical Rationale of Fermentation, says that "the oxygen acts in a similar manner to the friction or motion which affects the mutual decomposition of two salts, the crystallization of salts from their solutions, or the explosion of fulminating mercury. It causes the state of rest to be converted into a state of motion. When this condition of intestine motion is once excited the presence of the oxygen is no longer necessary; the smallest part of an azotized body in this act of decomposition increases an influence upon the particles in contact with it, and the state of motion is thus propagated through the substance; the air may now be completely excluded, but the fermentation or putrefaction proceeds uninterruptedly to its completion."

From the exposition which has now been made concerning decay, putrefaction, and fetor, not only on the authority but also in the words of those who are everywhere acknowledged as competent to give judgment in the matter, it seems evident that an efficient means of *delaying* decay and putrefaction, and of *preventing* fermentation in animal tissue, needs to possess an avidity for *oxygen* greater than that possessed by the tissues; or, in the last instance, by the ferment, whatever it may be. But, to destroy fetor, such an article must also have a

power to attract and absorb or destroy ammonia, sulphuretted and phosphuretted hydrogen, and similar offensive gases.

That earth has such a greed for oxygen has long been known, having been demonstrated by the great German savan, Humboldt, more than seventy years ago. He then showed by experiments on the air in the salt pits of Saltzberg that the power of the clayey earth was in this respect so great as to render the air irrespirable, incapable of sustaining combustion. Boussingault also demonstrated this power when making some researches on earth from various depths, in the vicinity of the Rhone in 1822. And Schübler says that this abstraction of oxygen gas cannot be doubted; that it is very decided as regards clay-loam and humus. In humus, he observed, there was a portion of the oxygen converted into carbonic acid.

Boussingault and Saussure were both confident, from their observations and experiments, that this effect of earth was to be ascribed, in part at least, to oxide of iron, which is always present in greater or less quantity in all those forms of earth which possess the power of preventing or delaying decay and putrefaction.

The former of the last-named observers mentions the fact that the clays which were brought up from a depth by a borer, and "were white, very speedily became blue by exposure to the air, and that in gaining color they condensed oxygen." He says that the iron "is in the minimum state of oxidation when the clay lies at a certain depth." One of the results he obtained in his experiments in the transformation of the protoxide of iron to the state of hydrated peroxide, namely, the generation of ammonia, confirmed as it has been by the experiments of many others, especially by those of Austin, in the oxidation of metallic iron under water, fully sustains the idea that the oxidation is at the expense of the air, its hydrogen and nitrogen being thereby set free, and combining to form the ammonia.

This property of absorbing oxygen is not, as it might be thought to be intimated, confined to the iron; it is also possessed by the alumina, and is developed in the other chemical actions which we shall hereafter see that the earth has the power of effecting.

Prof. Way, whose elaborate paper I have already quoted from most freely, came to the conclusion, from a careful study of his results, that clayey earth is a most "powerful deoxidizer;" and in commenting on the differences in the results between sandy and clayey soils obtained by Dr. R. Angus Smith, in filtering decaying animal solutions through them, he observes, that "sand by its surface attraction for air is a powerful oxidating agent, and that the filtration through such a medium is the most perfect way of exposing a solution to the influence of oxygen;" and finally, that Dr. Smith's experiments "serve to explain the rapidity with which manure disappears from sandy soils, but it is clear that there is a power of *an opposite* kind brought into action in good loamy soils, which retain manure, although in extent of acting surface and permeability to the air they are little if at all inferior to sandy land." "This power," he continues, "is evidently that of clay which is antagonistic to the oxidating power, combining with organic matters, and retarding, rather than hastening their destruction. Nitric acid has not in any case been found in these experiments to be a product of the filtration of organic matters through soils containing a fair share of clay, whilst on the other hand, coloring matters were actually precipitated unchanged, or in the state of insoluble pigment, technically known as 'lakes,' by mere mixture with white clay."

To the testimony which I have now furnished of the earth's power to absorb oxygen, and so to materially deprive the substances which undergo decay and putrefaction of that element, I will further add the results of some of my own experiments, of experiments made it is true in a crude manner, but none the less significant on that account, for had they been made with more accuracy of detail it is evident they would have furnished the same results in a more positive manner.

I. 1. To a reduction-tube, in which I had packed the bulb and the narrow portion on either side for an inch, with some cotton wadding, I attached the India-rubber air-pump apparatus of an atomizer, and satisfying myself on the flame of a gas-burner that a current of air passsed through this packing when forced from the air-pump; I then,

2. To determine whether the air in passing through this

packing of cotton was deoxidized, threw it on the flame of a lighted taper held up in an inverted glass-funnel, so near the apex as to make the flame smoke more than it did in the open air. The effect of the current so transmitted was to diminish the smoke and make the flame as brilliant as in the open air.

3. Removing the packing of cotton from the bulb and upper end of the tube, I replaced them with some dry, finely powdered, clayey earth, and a small pledget of earth on this, to prevent the blowing out of the earth, I determined the possibility of air being forced through it as through the cotton alone in a similar manner to Experiment 1.

4. I then tested whether the air so passed would aid combustion as in Experiment 2, but found that it would not; on the contrary, it made the taper smoke more profusely, and eventually put it out, not by the force of its current, but evidently from the deficiency of oxygen in the air which it supplied.

In Experiments 5 and 6, I made the comparison between cotton wadding and earth as to their power to transmit ozone, by interposing a Wolff's bottle, partly filled with a solution of permanganate of potassa and sulphuric acid, between the air-press and the reduction-tube, connecting the former with the glass tube, passing well down to the bottom of the Wolff's bottle, and the latter with the tube which merely penetrated the cork. In the instance of the cotton wadding (Experiment 5), I got immediately the evidence of the ozone by some of Schonbein's test-paper, applied moistened at the far end of the reduction-tube. But when the tube had the earth in it (Experiment 6), as in Experiments 3 and 4, I not only failed at first to get any discoloration of the test-paper, but even after I had continued the current through the solution for half an hour. Thinking at the end of that time that the failure was from the ozone having ceased to be generated, I disconnected the tube, and found that the generation of ozone was still going on in the Wolff's bottle.

7. I then tested the combustibility of the current of air sent through the apparatus, and found the same state of things as before, the taper burned freely in the current through the cotton only, but was extinguished in that through the earth.

8. To prove that this was a positively chemical action, and not a mere mechanical absorption, I subjected some of the same specimen of earth to a thorough maceration in dilute nitric acid, so as to raise all its ingredients to their highest state of oxidation, and then drying this on a filter, I put a similar quantity to that used in Experiment 3, and passed ozonized air through it as before, and the paper was instantly colored a deep blue.

9. I found a like result from some earth which had been in contact with a very offensive sloughing surface for twenty-four hours, and was thoroughly saturated with its discharges. Preparatory to testing it I freed this specimen as far as possible of all putrefying matter by thorough washings with distilled water. These washings were extended over a period of forty-eight hours, when the specimen seemed entirely free from odor. I then threw it on a filter of bibulous paper, and dried it before a grate fire. The ozonized air passed through it without any apparent difficulty or delay.

These results, in connection with facts which are familiar to many, suggest questions which at first seem unanswerable. Thus, every one knows that earth is the essential means of supplying all vegetable life with sustenance, and Liebig has shown that all the materials for such exist in fertile soils, in both a *chemically* and in a *physically* combined state, and that earths have the power of converting them from the former to the latter state.

Here, then, admitting such a power, which is a chemical one, in clayey earth, we have a stumbling-block at once as to oxygen, for in regard to it, it may be alike potent for evil as for good. But the same high authority admits even for *fertile soils*, that there is a great difference as to these two states; that with them elements in a physically combined state are very unequally distributed; whereas in the chemically combined, they are infinitely diffused over all the surfaces of the porous particles; and he observes, "The roots of a plant have no inherent power to overcome the *chemical* affinity which retains its elements of food in combination; hence those elements which are in *physical* combination with the soil, are the only ones which can be taken up and made available. It is in search of these,

as though with eyes, that the roots extend in certain directions in preference to others."

Hence, for the purpose of furnishing materials in such a state, it is recognized by all agricultural chemists, that a good soil, one capable of profitable cultivation, can not only reduce elements which are feebly combined, but has the power of severing the connection between the elements of compounds of the most stable character; that it takes these elements to itself, combines them with its own constituents, or holds them as compounds within itself, and then subsequently reduces them from the *chemically* combined to a free or *physical* state. Such earth, therefore, evidently exerts an *oxidizing* as well as a deoxidizing action on the material which it prepares for plants.

This oxidizing action is essentially in abeyance in the (dry) state of the aluminous earth which is the subject of our study here, and becomes developed in the opposite (or wet) states. There is, perhaps, no better known or easier mode of developing oxidation in earth than that of adding water to it, and the result not only furnishes us with the reason for the earth ceasing to act as an antiputrescent when it becomes wet, but for its then favoring putrefaction. (See the statements previously given as regards nitrogen, &c.) In the numerous experiments which I have made, this difference from the state of moisture has been clearly shown. A dry but readily oxidizable substance, when put in a vial and covered with thoroughly dried clayey earth, was preserved for a long time, indeed almost indefinitely, when the earth was thoroughly protected from extraneous sources of moisture. Whereas the same began to decay when the earth got thoroughly moistened; and when the decay so began, it went on more rapidly than if the article had been entirely unprotected. I have found, also, a difference when dry garden soil and dry clay were used as the coverings, the decay beginning almost immediately in the instances of the garden soil, and not until the state of dampness had existed for a longer or shorter time with the clay, the differences in the latter instances evidently depending on the facilities the clay had previously had of becoming charged with oxygen in a free state; thus the clay, which had been longest exposed in a finely pulverized state to the air, required less of moisture to

excite putrefaction of a substance covered by it than the same kind of clay which had been, up to the time of the experiment, kept in a solid lump in the same atmosphere. The color of a sample of clayey earth indicative of the amount of oxidation of its iron, has often proved a means of judging how readily oxidation of an article would begin in it.

The facts, before alluded to, that earths can combine various elements with their own constituents, or hold them as compounds within themselves, and then subsequently reduce them from the *chemically* combined to a *physically* combined state, not only show that oxygen may exist in an earth in a physically and also in a chemically combined state, but that the earth can act as an oxygenant, and that in passing, as the oxygen does, from the chemically combined to the physically combined state, it must be in the condition designated as *nascent* oxygen, in which chemists universally recognize it to be possessed of far greater activity than the oxygen which has been for some time in the atmosphere, or a physically combined state in the earth. What this state of oxygen, which Schonbein has designated as ozone is, there seems to be considerable difference of opinion, amongst various authorities, many, like Baumert and Williamson, considering it to be a compound with hydrogen, the teroxide of hydrogen; and others, like Tait and Andrews, that it is solely oxygen in an allotropic state. Then there are those who adopt Schonbein's notion, that it is permanently negative oxygen. All, however, concur in the opinion that the general characters of ozone are those of an oxidizing agent. They all recognize that it can corrode organic matter, bleach most vegetable colors, "is absorbed by moist iron, copper, &c., with production of their respective oxides; *moist* silver is even converted into the state of peroxide." But in some cases "ozone acts as a deoxygenant. Thus it decomposes peroxide of hydrogen and peroxide of barium, with evolution of inactive oxygen, derived both from the ozone and the peroxide, as represented hypothetically by the following equation: $\overset{-}{O}\overset{+}{O}\overset{-}{O} + \overset{+}{H}_2\overset{-}{O}\overset{+}{O} = 2\overset{-}{O}\overset{+}{O} + \overset{+}{H}_2\overset{-}{O}$." (Odling.)

Besides these, which have an important bearing on our subject, there is a very curious action by dry oxides of some of the metals on *dry* ozone, mentioned by many chemists, which

is still more important to us, and that is, their decomposing such ozone in *unlimited quantity*, and that too without undergoing any alteration of weight by the reaction. The same is accomplished by *dry* silver leaf or filings. "These unlimited effects may be explained," Odling tells us, "by the successive or simultaneous occurrence of oxidation and reduction. Thus, dry silver leaf is at first obviously oxidized by ozone, and the oxide of silver so formed is then reduced, and so on consecutively."*

By the presence of some of such oxides, which is readily proved, we can see a most satisfactory reason of the failures experienced in attempts, even long-continued, to force ozone through dry elayey earth, or for the contrast in the effects of the *dry* and *wet* states of such earths, the blackening of the silver stitches when the dressing had become saturated, and their retaining their brightness as long as the earth was dry, effects which were always noticeable under the circumstances.

This behavior of ozone as a deoxygenant explains also the difference between its action and that of ordinary oxygen in the matter of putrefaction and decay, and does away with what has always seemed an incongruity, namely, that oxygen, which under ordinary circumstances always acts as a destroyer or consumer, should when recently generated (in ozonized state) be capable of acting as a preserver of such readily destructible substanees as flesh and vegetable matters.

"The occurrence of oxygen in such a state in earths of various kinds," Liebig says, "is not a matter of inference; it is noticeable everywhere after a rain, in the air of our fields, and especially during the prevalence of a thunderstorm, the exhilarating effects of which on vegetation is universally recognized. Its exhaustion by a drought, as we can now explain by the action of the dry oxides, may serve to indicate a source of the pestilences which we see following sueh a state of weather. The wet state long continued may cause similar troubles by bringing about too much of the physically combined or destructible state of oxygen."

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* Manual of Chemistry, Part I, p. 95. By Wm. Odling, M.B. F.R.S. London, 1861.

II. Observations on the temperature of parts with which the earth has been some time in contact, made on many of the cases whose histories I have given, and on others since my services at the hospital in 1869, have developed some very remarkable results, which go far to sustain the idea of an anti-oxidizing or deoxygenant power of the earth over parts covered by it. In all instances where inflammatory action had effected a positive increase of temperature in the diseased part, as shown by the thermometer, in contrast to the temperature of a corresponding part not suffering from such action, there was not only a reduction of temperature, so as to make the part lose its excess, brought about by covering it with dry powdered earth, but this effect was found to be still there even when the earth had become partially saturated with the discharge, and as late as at the end of twenty-four hours after the earth was put on, provided it had not become entirely wet through by the discharges, or was not covered by waxed paper or other like substance, which could completely prevent all evaporation, and so early cause the earth to become thoroughly wet from sweating the part with which it was in contact. Nay, more, I have seen this effect of the earth so great that it would reduce the temperature of the surface of the part to the minimum of the blood in health, although the patient was at the time suffering with constitutional (febrile) disturbance of such a character as to make the temperature in his axilla over 102° Fahr.

I made recently (March, 1870), and have repeated it since on other cases, an observation in this matter of singular significance, on a lad of some 19 years, who had been suffering with intractable ulcers on the leg and thigh from inodular tissue in the vicinity of the left knee. In this case I made free incisions in the sound tissue of such an extent on either side of the ulcer as to allow of its speedy healing. The ulcers and wounds were subsequently dressed with dry clayey earth. Some of the dry finely-powdered earth was first heaped on them, and then the whole circumference of the limb for a distance above and below was enveloped with a cloth (coarse muslin) covered by a thick paste of the same earth, and this was retained in place by a sheet of white unglazed paper and a roller bandage. The incisions were

of no trifling character, all of them being over three inches in length, and two on the leg were over seven inches long. The operation was of course done under the effects of anæsthesia, and was followed by considerable febrile reaction. On one day when this fever was at its acme, and the temperature in the axilla 102°, and that in the ham of the sound limb 99.5°, I found the temperature in the most inflamed part of the diseased limb (in the ham) only 96.5°. This temperature was taken when the dressing had been on twenty-four hours, after the roller and paper had been removed some time, by insinuating the bulb of the thermometer under the dry cake of clay adhering to the muslin, and passing it down on to the surface of the sore some two or three inches from the point at which it entered under that envelop, and to allow of ample time for the observation I continued the thermometer in this position for over twenty minutes without ever being able to detect it above the point just stated.

III. Analyses made for me by Dr. Newton of earths which had been used as dressing failed, and as Mr. Way of earths used as filters of manure had, to detect any evidences of nitric acid having been generated in them by the work they had done.

Secondly. To prove that the earth we have been using is by chemical action an efficient deodorizer or destroyer of the fetor of decaying animal substances, we have to show that it has the power to attract, absorb and destroy the gases which are the sources of such fetor. Now this subject has been studied in a most masterly manner by Prof. Way. Indeed it was to ascertain the character of this power in earth that he undertook the investigation which led to this paper, from which I have already quoted so freely, and to which he devoted many months of his personal attention. His investigations, as he tells us, "took their rise in observations made to him fully two years before his publication, in 1850, by the Rev. Mr. Huxtable and Mr. H. S. Thompson." The former of these gentlemen stated to him that he had made an experiment in the filtration of the liquid manure in his tank through a bed of an ordinary loamy soil, and that after its passage through this filter-bed the putrid urine was found to be deprived of *color* and *smell;* "in fact, that it went in manure and came out water."

"This of itself," as Prof. W. remarks, "was a singular and interesting observation, implying as it did, the power of the soil to separate from solution those organic substances which give color and offensive smell to putrid animal liquids." Mr. Thompson, about the same time, mentioned to Mr. W., "that he had found that soils have the faculty of separating ammonia from the solutions, a fact appearing still more extraordinary, inasmuch as there is no ordinary form of combination by which we could conceive ammonia to become combined in a state of insolubility in the soil."

But Mr. Way has since himself demonstrated that an ordinary soil has the power of collecting from the air and incorporating with itself, gaseous carbonate of ammonia contained in the atmosphere with which the soil was in contact, and that it has the power of absorbing ammonia itself when presented in purity as an atmosphere. He has shown by experiments that clayey soils from a depth of 1½ to 2 feet, and those from 3½ feet, had this power to a greater extent than a top soil. (Op. cit., p. 507–8.) The difference between the earth from 3½ feet and that from the surface being more than double in favor of the former.

The following are the actual figures:

250 grs. of	top soil	from a London clay	absorbed	1 513	grs.
" "	soil	from 1½ feet depth of same	"	2.375	"
" "	"	" 3½ " " "	"	3.201	"
" "	loam	" 4 feet below surface	"	1.087	"

The difference being evidently due to the quantity and virgin condition of the clay in each specimen.

Mr. Way, in the course of his experiments, did not, however, confine his attention merely to the earth's power to absorb such ingredients from *their solution.* He also investigated and even demonstrated, in the most positive manner, its power to abstract them from the air. It had been previously shown by Liebig that the earth had some, at least, of its greed for ammonia satisfied by the supply which it got from the atmosphere and the rain. "Experiments made in the laboratory at Geissen, with the greatest care and exactness," had detected the presence of ammonia in rain-water, also in snow-water, and

this ammonia was observed to have an offensive smell of perspiration and animal excrements, a fact which Liebig says leaves no doubt respecting its origin. But the immense amount so generated in the atmosphere by the constant putrefaction of both animal and vegetable substances on the surface of the globe, and the immense demand made for it by the products of the earth, would seem to indicate that such a means of carrying it away were insufficient.

"If by filtration through a soil the animal matters of urine were merely altered, transformed for instance into nitric acid, they need not necessarily (and, in the case of nitric acid just stated, decidedly would not) be retained by the soil. But numberless observations, in practical agriculture, would, when rightly interpreted, lead us to believe that fertile soils have the power of arresting matters containing nitrogen, and retaining them in such a form that in due time they become available as food for plants. I am, he says, unable to give more than a general sketch of the property of soils to combine with the organic portion of manure, but the experiments that have now to be described, though inadequate to explain the cause, sufficiently establish the fact, and they must be received as an earnest of the rich reward awaiting the further prosecution of this most interesting research."

The following are some of Prof. Way's experiments which are important for us to consider:

EXPERIMENTS IN FILTERING PUTRID URINE.

Experiment 92. Two filtering-tubes, each twenty-four inches long, were filled to the depth of eighteen inches with Mr. Huxtable's light soil. Upon these filter-beds a quantity of highly offensive stinking tank water was poured. Owing, however, to the fineness of the soil, and to a sedimentary deposit from the liquid at the surface of the soil, the filtration was very slow, and at the end of thirty-six hours none of the liquid had passed. The soil was then pushed out of the tubes. The liquid had so far penetrated the filter that the portions near the bottom were quite wet, but they exhibited no smell, and it was not till twelve inches of the wet soil had been ejected that any, even the smallest, smell of the urine was perceptible.

EXPERIMENT 93. The same soil was mixed with its own weight of white sand, to make it more permeable; in other respects the experiment being made in the same way as the last. The liquid did not pass for several hours, but ultimately more than one ounce of it passed, quite clear, free from smell or taste, except a peculiar earthy smell and taste derived from the soil. It contained no ammonia, as would be expected from experiments already described, but salts of lime in considerable quantity.

These experiments sufficiently corroborate Mr. Huxtable's observation of the action of a soil upon the coloring matters and substances producing smell of putrid urine. They have been repeated with many different soils, and under every possible combination of circumstances, but still with the same effect. It would be tedious and useless to relate all these experiments in detail, and it may be sufficient to state that similar results were obtained by acting upon putrid human urine, upon the stinking water in which flax had been steeped, and upon the water of a London sewer. That the power of the soil in all these cases is due to the clay contained in it there is not the slightest doubt. Many similar trials were made with sand, but although the color, so far as it was due to suspended matter, was in some degree reduced, the offensive character of the solutions was but slightly modified. On the other hand, the pure white clay, so often before mentioned, proved an admirable absorbent both of color and smell. It is worthy of remark, that by merely stirring up a portion of soil or of pure clay with the solution, the same result is obtained, though not in the first instance so perfectly. If, however, the liquid, in great measure deprived of color and taste, is poured off, and treated with a second quantity of the absorbing soil, the effect is equally complete as when a process of filtration has been adopted. Solutions of different coloring matters, such as those of logwood, sandalwood, cochineal, litmus, &c., when filtered through or shaken up with a portion of clay, are entirely deprived of color. Alumina is known to possess an extraordinary power to combine with coloring matters, and is extensively used in dye-works as a mordant. It would therefore naturally be supposed that the decolorizing power of clay was due to the

free alumina; but granting even that free alumina exists in clay, of which there is no sufficient proof, it is certain that other compounds of alumina exist in the clay possessing this power. Thus, white clay when boiled with hydrochloric acid (which dissolves out the free alumina), and subsequently well washed, retains apparently in undiminished force the power both of precipitating the coloring matters of logwood, &c., and also of decolorizing and deodorizing putrid urine and other offensive animal solutions, and we must therefore believe that there are compounds of alumina with silica, having in some respects the same chemical properties as alumina itself. In what form of combination these coloring matters and the organic substances giving smell are retained by the clay it is very difficult to say. All organic matters are certainly not abstracted from solution to the same extent. Thus a colorless solution of sugar will pass apparently unaltered through a filter of clay and sand, whereas if it be colored the clay will act like animal charcoal, completely removing the coloring matter.*

It concerns us very much to know for what substances and to what extent this power of soils to unite with organic matters is operative. So far as the experiments have at present been carried, it would appear that there is a greater power in the soil for retaining the products of the decay of animal matters than the animal matters themselves.

Fresh urine is purified, that is to say deprived of animal matters and salts, by filtration through clay, but the action appears to be much more limited than when the urine is used in a state of putridity. Still there is good reason to hope that

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* The way in which sugar is made perfectly white, it is said, was found out in a curious way. A hen that had gone through a clay mud puddle, went with her muddy feet into a sugar-house. It was observed by some one that wherever her tracks were, the sugar was whitened. This led to some experiments. The result was, that wet clay came to be used in refining sugar. It is used in this way: the sugar is put into earthen jars, shaped as you see the sugar-loaves are. The small ends have a hole in them. The jar is filled with sugar, the clay put over the top, and kept wet. The moisture goes down through the sugar, and drops from the hole in the small end of the jar. This makes the sugar perfectly white.

in the case of fresh urine the power of good soils is practically sufficient.

Many experiments have been made with a view of gaining a general notion of the extent of the power in question. In one instance five hundred grains of clay mixed with half a pint (thirty-five hundred grains) of fresh urine deprived it of color, and carried down all the animal matter. Clay appears to have a remarkable action in reference to the fermentation of organic matters. It seems indeed to oppose fermentation, as will be seen in the following experiment.

Experiment 94. Three quantities of fresh urine of two thousand grains each, were measured out into similar glasses. With one portion its own weight of white sand was mixed, with another its own weight of white clay, the third being left without admixture of any kind. When smelt immediately after mixture the sand appeared to have had no effect, whilst the clay mixture had entirely lost the smell of urine; they were all decidedly acid to test-paper. The three glasses were covered lightly with paper, and placed in a warm place, being examined from time to time. In a few hours it was found that the urine containing sand had become slightly putrid, then followed the natural urine; but the quantity with which clay had been mixed did not become putrid at all, and at the end of seven or eight weeks it had only the peculiar smell of fresh urine, without the smallest putridity. The surface of the clay, however, became afterwards covered with a luxuriant growth of conferva, which did not happen in either of the other glasses. This is a remarkable experiment, and one from which eventually much instruction may be derived.

The reason that the sand accelerates the fermentation of the urine is no doubt this: All bodies possess a surface attraction for gases, and of course, therefore, for common air. This attraction, which enables them to condense a certain quantity of air on their surfaces, is in direct relation to the extent of those surfaces. In mixing sand with the urine we are in effect exposing the latter to a largely increased surface of air, the oxygen of which is necessary to commence the putrefaction, and thus hastening the changes which soon or late would occur in the urine naturally. But what shall we say of the action of the

clay? That it retards or changes the nature of the putrefaction is evident; but the question is, does it prevent the conversion of the animal matters into the ordinary products of decay, or does it allow of that conversion and absorb those products as they are formed? This is a most vital question to practical agriculture, clearly affecting our views of the state in which animal manures should be employed, and affecting also in the highest degree the theoretical notions of vegetatable nutrition.

Should it be proved that the clay in soils possesses the power of altogether arresting putrefaction, and that urea and other animal matters remain unchanged in the soil, we shall be driven to allow that plants have actually the power of feeding on these primary compounds, a view which it is almost needless to say has been all but abandoned by chemists and vegetable physiologists of the present day. An experiment now to be described is rather in favor of the belief that clay actually prevents the putrefactive process.

EXPERIMENT 95. Fresh human urine was filtered through white clay mixed with its own weight of sand. The first portion came through colorless; by and by, however, the urine itself passed through apparently unchanged. Several ounces were collected, and by accident remained on the table beside a quantity of the same urine which had not been so filtered. At the end of several days it was observed that the filtered urine was quite sweet, whilst the other had passed into a state of putridity; and for more than a month during which it was kept this filtered quantity remained in the state, having the smell of fresh urine, without the smallest putridity; the clay, in fact, had destroyed its power of fermentation. It is believed that the spontaneous putrefaction of urine is due to the presence of portions of mucus from the bladder, and the idea will suggest itself that filtration, by removing this mucus, destroys the susceptibility to spontaneous change; but I have found that filtration through the finest paper does not prevent urine from fermenting, and further that by merely stirring up clay with urine, the latter being greatly in excess, allowing the liquid to clear itself, and pouring it off, further change is altogether prevented. It is quite likely that the clay combines with the organic bodies acting as ferments, and thus removes them from

the solution; but however it may be explained, of the fact there can be no dispute. The result in the first experiment where urine and clay were digested together is susceptible, as before said, of two explanations: 1st, that no putrefaction takes place; or, 2d, that the products of putrefaction are absorbed, and consequently do not become evident to the senses.

We have seen that clay destroys the smell of putrid urine; consequently so fast as it became putrid the evidence of putrefaction by smell would be destroyed. In this way we may suppose the whole of the urea and other animal matter to pass into secondary and even final or ultimate products of decomposition without the smallest external sign that such change had occurred. But this conclusion is irreconcilable with the fact that clay, when used in small quantity, although it removes only a part of the animal matters of urine, destroys the tendency to spontaneous putrefaction in that which is left. The inference from these united observations would be, that urine and other animal liquids, when mixed with the soil, do not undergo the ordinary decomposition. No decided opinion, however, should be formed on so important a subject upon imperfect data; and for the present we must be content to believe simply that the phenomena of fermentation and putrefaction are very much modified when the soil comes into play.

An experiment of the same nature as those before mentioned was made with human fæces, which were covered in two glasses; the one portion with sand and the other with white clay, each to the depth of about two inches. The materials were loosely placed in the glasses, and not incorporated together, so that the air had access to the excrement, although imperfectly. The smell from the glass containing sand, particularly after some little time, was very bad, but from the fæces and clay no other than a slightly acid but not putrid smell was for weeks evident.

Having now brought forward ample proofs of the existence, in reference to the organic and inorganic substances of manure, of a power in soils, which has hitherto hardly been suspected, I shall endeavor to give a practical idea of the extent of the property when it acts upon the mixed constituents of a manure, by describing two experiments which have been

made with that view. The first of these shows the action of white clay upon flax-water, the putrid liquid which results from the steeping of the flax plant; the second experiment exhibits the action of a soil upon the water of a London sewer.

EXPERIMENT WITH FLAX-WATER AND CLAY.

The following is the analysis of the flax-water used in this experiment:

An imperial gallon contained

	Grains.
Organic matter,	180.80
Phosphoric acid,	8 76
Sulphuric acid,	18 08
Carbonic acid,	21.53
Lime,	33 06
Magnesia,	8 54
Peroxide of iron,	17 44
Potash,	48 84
Soda,	none.
Chloride of sodium,	42 21
Chloride of potassium,	60.83
Silica,	4.93
Total solid matter in a gallon,	445.02

"The organic matter above contained 3.28 grains (in a gallon) of nitrogen, none of which appeared to be in the form of ammonia."

Experiment 96. With 48 ounces of this flax-water 16 ounces of white clay were mixed in a wide-mouthed bottle, the materials being well agitated together. The fetid smell of the liquid was greatly diminished, but not entirely removed. After the addition of 8 ounces more of the clay, the offensive odor of the flax-water was entirely removed, but the liquid still retained a peculiar odor, which seems to be due to some acid substance formed in the fermentation of flax. The clay was now allowed to fall to the bottom, and the clear and colorless fluid was decanted off, and evaporated carefully to dryness. The residue still contained organic matter of some sort, but it was entirely free from nitrogen. Neither did it contain phosphoric acid, potash, or magnesia.

"The following analysis exhibits the composition of the mineral residue of an imperial gallon of this liquid:

	Grains.
Oxide of iron,	5.20
Lime,	32.18
Carbonic acid,	not ascertained.
Sulphuric acid,	20 34
Chloride of sodium,	86.78

"It will be observed that the quantity of lime and sulphuric acid in the resulting solution are, within errors of experiment, the same as in the original liquid; the quantity of chlorine is also as nearly as possible the same in both liquids; but in the original flax-water, part of it was in eombination with potassium, whieh after treatment with clay, has been replaced by sodium. We have here two results which were unexpected; the first, that the quantity of lime should not be inereased, whieh seems opposed to the principle before laid down, that lime replaces in the liquid the potash and magnesia previously combined with sulphurie and muriatic acids; the second peculiarity is the existence in the resulting solution of much more soda than existed in the flax-water itself. This soda can only have been derived from the elay, which we find from the analysis (page 320) contains the alkali in eonsiderable quantity. It would seem therefore, that in the present instance soda, and not lime, has acted the part of the substituting base."

By the earliest of his experiments, Prof. Way so far narrowed down the question of the origin of the power of the earth as a deodorizer, as to bring it "to the clay existing in all soils." (Page 125.) "It still, however, remained to be considered whether the whole elay took an active part in these ehanges, or whether there existed in elay some chemical compound in small quantity, to whieh the aetion was due. This question was to be decided by the extent to which elay was able to unite with ammonia or other alkaline bases; and it soon became evident that the idea of the clay, as a whole, being the cause of the absorptive property, was ineonsistent with all the ascertained laws of chemical combination.

"I was, indeed, eonvinced, at a very early period of this inquiry, that the absorptive property was due to a small quan-

tity of some definite chemical compound existing in the clay, and possibly not constituting more than four or five per cent. of its whole weight. I had every hope that, although I might not be able to separate this substance from clay—for of that there was little prospect—it might yet be possible to form it artificially from other sources at the disposal of the chemist, and by producing a compound, or compounds, having the same properties as those shown to be possessed by clay, to prove their identity with the active principles of clay itself, and thus indirectly establish its real nature.

"When a solution of silicate of soda or potash is added to a neutral solution of a salt of lime, or to lime-water itself, a gelatinous precipitate is obtained, which is silicate of lime; this compound may be washed in distilled water, in which it is very slightly soluble. Its composition varies according to the relative proportions of soda and silica in the liquid from which it is formed; but it is possible to obtain it of definite composition. The silicate of lime thus formed was digested in solutions of muriate of ammonia, but without success; it did not absorb ammonia, and is not therefore the substance to which the absorptive property of soils is due.

"The silicate of lime is the type of simple silicates of the same class, which would be quite unlikely to act otherwise than it did with salts of ammonia. The class of simple silicates was therefore abandoned, and attention was turned to the possibility that the absorptive property might be due to some of the compound silicates present in clay, and derived from the granitic rocks to which clay owes its origin. Fragments of such rocks are found still to be present in clay, and the most commonly known are felspar, the double silicate of alumina, and potash, and albite, which is a soda felspar, or double silicate of alumina and soda. There is, also, a similar double silicate of alumina and lime. These different natural silicates, finely powdered, were digested in a solution of sal ammoniac, but none of them possessed the power of combining with its ammonia. It is not, therefore, to the undecomposed remains of the granitic rocks that the absorptive power of clay is to be referred.

"It was still possible, however, that these double silicates, when formed artificially by precipitation, might be capable of

effecting that which in the mineral state they were unable to accomplish, because it is a well-known fact in chemical science, that substances recently formed, and in the highly divided state resulting from precipitation, may be much more active to produce or undergo chemical change, than after they have, as in the case of the granitic rocks, been subject to the agency of heat.

"Accordingly, the next attempt was to produce artificially, and without the aid of heat, salts of the same composition as felspar and albite. This was done by adding to a solution of alum a solution of silicate of soda; a gelatinous precipitate was produced, which, when washed and dried, was found to contain soda, and to be not silicate of alumina, but a compound of this latter silicate with silicate of soda. This substance, therefore, resembles albite, which has been before mentioned as a double silicate of alumina and soda. The experiment was made, as in the other cases, of digesting this salt in solution of muriate of ammonia; the excess of the latter salt being washed away by successive quantities of distilled water, the precipitate was dried and examined for ammonia, which it was found to contain in very considerable quantity."

In his experiments with these artificial salts Mr. Way observed, that there is a regular order of decomposition between the silicates of each base and ordinary salts of other bases; thus, the soda silicate is decomposed by salts of either lime, potash, or ammonia; the potash silicate again is decomposed in its turn by lime or ammonia; and lastly, the lime compound by ammonia. The different bases may be arranged in the order in which they replace each other from the silicate as follows:

Soda;
Potash;
Lime;
Magnesia;
Ammonia.

That is to say, that from a silicate of alumina and any one of these bases, the base will be dislodged by a salt of any of those under it in the list.

Nitrate of potash, for instance, will turn out soda from its silicate, and a potash silicate will be formed; whilst ammonia will replace any of the other bases. Of course the reverse of this action cannot occur, and therefore the double silicate of alumina and ammonia cannot be decomposed by any neutral salt of the other alkalies. In glancing again at this list, it will be seen that all the silicates, without exception, are capable of absorbing ammonia. This is very important, inasmuch as it exhibits so very certain a provision for the retention of ammonia in soils.

It matters not whether one or more of these compounds is present as a soil, so that any one of them is there; the ammonia added in manure is derived from the atmosphere, will equally be retained. "Indeed this list of the order of these decompositions strikes me," Prof. Way says, "as of singular interest, in indicating the care and solicitude of nature in the preservation of the different substances which are essential to the growth of plants, in direct relation, as far as we have been able to learn, to their relative importance. Ammonia, for instance, may well be considered as of the very first consequence to vegetation, and for its retention four other alkaline bases are made responsible. Next comes potash, which is also of very great agricultural importance; whilst, at the other end of the list, we have soda, for the retention of which no provision is made, and which is liable to be displaced by salts of all the other bases. Now, it so happens, that almost all those chemists who have been much engaged in the examination of the ashes of plants have come to the conclusion that soda is not necessary to vegetation, that is to say, not as a constituent of plants. In the seeds, which are the only perfected parts of plants, soda rarely exists, except in insignificant quantity, and then only as common salt, present, probably, from want of perfect maturity of the seed. In the succulent parts of plants, it is true, soda is found in quantity, but in all probability it only there exists as a part of the unelaborated juice of the plant, and in virtue of the great quantity of water contained in it. It is most interesting, therefore, that not only is there an absence of retentive power for this alkali, but it is also made subservient to the preservation of all those that are of importance.

Lime, which stands next on the list, is again less cared for than potash or ammonia, probably because its abundance in nature is generally a sufficient security. It is necessary to state, in reference to these decompositions, that the rule laid down only applies to the action of the salts of different bases on the silicates. Thus, as has been said, sulphate of lime cannot cause the displacement of ammonia from its silicate; but, on the other hand, the action of the caustie alkali-lime itself would be very different, for not only would silicate of ammonia be decomposed by lime, but the potash of silicate of potash, and alumina, would also be displaced by it.

"The action of heat on these silicates is peculiar. It has been before stated, that they contain water of combination, which is driven off at a red heat, but after being strongly heated they lose their property of acting on different salts. For instance, the double silicate of soda, after being heated to redness, no longer absorbs ammonia, or is decomposed by salts of potash.

"This is the reason why felspar and albite, substances of the same eomposition in all other respects as the artificial silicates, are devoid of the power of absorbing ammonia. It is only in the state of hydrates that the double silicates possess the property in question; and this, again, aceounts for the fact which was observed, that the retentive power of clay and soils in general for ammonia was very much diminished, and in some cases entirely destroyed, after the soils had been heated to redness. We have here a further proof of the identity of these double silicates, artificially produced, with the substances in the soil which give it the power of absorbing the salts of manure. I do not think indeed that this point admits of much dispute. We find that a power is possessed by soils, which is not referable to the organic matter, the sand, or carbonate of lime which they contain; and further, that pure clay, free from any of the ordinary salts of lime or soda, possesses this property in a high degree. Believing that the activity of elay can only be due to some compounds of silica, we are led to examine some of these eompounds anew; and whilst it is ascertained that the ordinary simple silicates are not the salts we are in search of, and that the natural double silicates of the type of the felspars, which are likely to exist in clay, are equally devoid of the

requisite properties, a new class of substances is discovered, having, though in a far higher degree, all the qualities of the clay itself. It seems that this is, on the whole, as conclusive as any evidence of the kind could be.

"But again, it has been found that carbonic acid water dissolves ammonia from the double silicate in considerably larger quantity. Thus, 1000 grains of water saturated with carbonic acid digested in the double silicate dissolved out 0.0366 grains of ammonia; and at the same rate, an imperial gallon would dissolve 2.527 grains. As water then naturally always contains this gas, it follows that the solubility of the ammonia will in practice be considerably greater than that given for distilled water. Again, it so happens that the double silicate is still more soluble in a solution of common salt. Thus, 1000 grains of a solution of common salt, containing 1.97 per cent. of salt, was found to dissolve 0.33 grains of ammonia, or at the rate of 23.1 grains in the gallon, which is twenty times as much as with pure water. And in a second experiment, where the solution of common salt was of different strength, or 0.1 per cent. of salt, the quantity of ammonia dissolved was 0.047, or 3.32 grains to the gallon. It is probable that many other salts, such as the sulphate of soda, for instance, would possess the same solvent power, and this influence cannot fail to be brought into play, because, wherever a salt of ammonia is arrested by the double silicate of soda or other compounds of the class, a corresponding alkaline salt is formed which acts upon the newly produced ammoniacal silicate. So that either by solubility in carbonic acid water, or in the various salts which are produced in the soil, it is easy to see that the ammonia may be dissolved in quantity sufficient for all the purposes of vegetation.

"In passing it may be well to suggest that this extra solubility of these silicious compounds in carbonic acid may in part explain the action of carbonaceous matters in the soil. Independently of being a real food of plants, by the carbonic acid which they furnish on decomposition, they would also indirectly increase the supply, not only of ammonia, but of all the other alkaline substances which are bound up in the form of silicates of small solubility."

"It has always been a matter of question with chemists in what way the beautiful coating of silica could be laid on wheat straw, and as the soluble compounds of silica hitherto known have been those of potash and soda only, it has been necessary to suppose that solutions of these salts were decomposed by carbonic acid, and that the silica in solution in water was subsequently carried to the straw, and there deposited.

"The discovery of the silicate of ammonia, however, affords a much more satisfactory explanation of this phenomenon. When the double silicate of ammonia and alumina is treated with water, silicate of ammonia dissolves, and this solution, when carefully evaporated, leaves on the dish in which the operation is performed a transparent varnish of silica, hard and brittle, and splitting into thin plates like mica. In the act of evaporation the water carries with it the ammonia, leaving only silica behind.

"What more natural than to suppose that the silica of cereal crops is thus left by the constant transpiration of water from the surface of their leaves and stalks? A circumstance which in an interesting way favors the view now suggested, is the observation made by Mr. Lawes that, in the growth of wheat, much more ammonia is removed from the soil than is found in the crop in the shape of albuminous matters; that, indeed, to produce one bushel of wheat, containing in round numbers, one pound of nitrogen, between four and five pounds of nitrogen as ammonia are required in the soil.

"This singular observation, which has been hitherto without explanation, becomes intelligible enough if it be conceded that the ammonia is engaged in carrying the silica to the straw, and is, if we may so say, wasted in the act. It is also remarkable that this loss of ammonia is apparently confined to the cereal crops and grasses, and is not found to occur in plants that have not silicious stems.

"I do not wish to push this conjecture beyond its proper limits, and therefore merely mention it as worthy of being borne in mind. If it be in any degree correct, then the action of common salt in strengthening and brightening the straw of wheat and barley, which is the best ascertained of its effects as ma-

nure, is immediately traceable to the greater solubility of the silicate of ammonia in a saline solution.

"Hitherto we have spoken only of the power of the double silicates to unite with ammonia, and separate it from solution. More important, if possible, is the faculty which some of these salts possess of abstracting ammonia from the air. It has long been known that soils acquire fertility by exposure to the influences of the atmosphere; hence, one of the uses of fallows. It has also been generally understood that clay possessed a power of absorbing ammonia from the air, but only through the influence of rain or dews to bring down the volatile carbonate. This latter condition, however, is not at all necessary. I find that clay is so greedy of ammonia that if air charged with carbonate of ammonia, so as to be highly pungent, is passed through a tube filled with small fragments of dry clay, every particle of the gas is arrested. In the same way, if into a bottle filled with air similarly impregnated a little ordinary dry soil is thrown, and the bottle is then shaken once or twice, all ammoniacal smell is destroyed. The double silicate of alumina and lime is in these cases also the cause of the absorption. If, instead of clay, sand be placed in the tube, no obstacle is presented to the passage of the gas; but by mixing with the sand a few grains of the lime silicated we can immediately arrest it.

"The avidity of this silicate of lime and alumina for carbonate of ammonia is most marked. A few grains of the salt were spread upon a piece of paper, and covered with a glass bell jar, some fragments of dry carbonate of ammonia in a small dish being also covered by the jar. In a few hours the silicate was found to have absorbed between two and three per cent. of ammonia, and the action will go on until the salt is entirely saturated. The chemical change in this case is very simple; the carbonic acid of the carbonate of ammonia attacks the lime, forming carbonate of lime, whilst at the same time the double silicate of alumina and ammonia is produced. It is remarkable that the corresponding soda silicate does not absorb carbonate of ammonia; or, at all events, if it does so in an atmosphere highly impregnated with the volatile alkali, it gives it off again so soon as it is exposed to the air; in ordinary circumstances, therefore, it does not absorb ammonia from the air.

	One crop.	Twenty crops.	Percentage of the soil removed by twenty crops.
Silica, . . .	170 lbs.	3400 lbs.	0.152
Phosphoric acid, . .	30 "	600 "	0 027
Sulphuric acid, . .	8 "	160 "	0.007
Lime, . . .	16 "	320 "	0.014
Magnesia, . . .	10 "	200 "	0 009
Potash, . . .	40 "	800 "	0 036
Soda, . . .	3 "	60 "	0 003
	277 "	5540 "	0 248

"We have seen that whenever a salt of ammonia or of potash reaches the soil, and gets distributed through it, a change occurs. A double silicate of alumina and ammonia or potash is formed, and the salt which was added no longer exists there. The ammonia or potash henceforth exists in the soil only in the form of a silicate, and is presented to the roots of a plant only in that form, or in the form of carbonate derived from it by the action of carbonic acid in the soil. And inasmuch as all average soils possess this property of conversion in more than the degree necessary for the quantity of manure which reaches them, the inference is obvious and incontestable that nature has given to the soil this power for the specific purpose of preparing the food for plants, and we then have the soil occupying a place intermediate between that of mere dead matter and the living organism of plants. Further, if the combination of these two, so to speak, innocent and mild acids, the carbonic and silicic, are the only ones appointed by nature, it follows that the salts of mineral acids, the sulphates and muriates, are not suited, indeed, positively injurious to vegetation."

Quite recently Mr. Robert Warington, Jr., has contributed through the Journal of the Chemical Society of London (series 2, vol. vi, January, 1868), a valuable paper on the part taken by oxide of iron and alumina in the absorptive action of soils. In this paper he shows by experiments that "ferric oxide and alumina of a natural soil have the same power of removing phosphoric acid from solution and combining with it, which he had shown to be possessed by the precipitated hydrates. Hence it is evident that the phosphate of iron and aluminum must be the ultimate state of all phosphoric acid

which they can act upon." He admits, however, "that it is too much to say that a soil in every case removes phosphoric acid from solution solely by virtue of the oxide of iron and alumina which it contains." Dr. Voelcker has shown "that when a solution of superphosphate of lime is brought in contact with various soils, it is the soil which contains most calcium that generally removes the greatest quantity of phosphoric acid." Way has also told us "that soils have the property of removing carbonic acid from its solution in water, so that a saturated solution of phosphate of calcium in carbonic water would deposit on contact with soil."

"There are thus," Mr. Warington goes on to remark, "several ways in which phosphate of calcium may be thrown out of solution on contact with soil, but though the oxide of iron takes no part in these comparatively sudden actions, it must in every case *finally* convert the phosphate of calcium into a phosphate of iron."

Dr. Peters (Ann. der Landwirthschaft, January, 1867, p. 31), draws the conclusion, from an extended research on the subject, that by far the greater part of the phosphoric acid contained in soils is combined with iron and alumina, which confirms Mr. Warington's view.

Mr. Warington has demonstrated in the same way the power of these ingredients of yellow clay to absorb the chlorides, carbonates, sulphates, and nitrates of the alkalies and alkaline earths.

As to the nature of this action he says, "there is a considerable amount of evidence that the absorption is due to a weak chemical affinity. First, it is found that a decided preference is shown for the salts of certain acids. It is also observed that in these cases of ready absorption the salt is nearly always decomposed to a considerable extent. That to the action of such affinity the absorption should be referred in every case is very probable, but hardly permits of being established by evidence."

Besides these ingredients of yellow clayey soils, Mr. Warington admits that the hydrated silicates (such as Prof. Way has tested), also possess these absorbent powers.

The experiments of Henneberg, and Stonemann, E. Peters,

and Kullenberg, have shown that of all the salts of the alkalies experimented with, the phosphate was the salt from which the soil removed the largest quantity of base, the absorption of phosphate even exceeding that from the carbonate. This fact agrees remarkably well with what we have now seen to be the properties of oxide of iron and alumina. They require no aid from a calcium salt to enable them to decompose an alkaline phosphate.

Having shown, not only the *possibility*, but also the *probability* of the earth's action as an *antiputrescent*, or preventive of decay, being due to its power as a *deoxidizing agent*, and to its greed for ammonia, whereby it acts also as a deodorizer, we may next pass to the question, wherein is its influence over the results where *vital action* is recognized as having full sway? Now although we admitted that the conditions which we designate by the term *decay* are essentially the results of the absence of *vital action*, it is not to be inferred that the presence of vitality or life is a guarantee for the *absence* of *all* decay. Indeed, "life is not as was once thought the power of resisting decay. On the contrary, the waste which occurs in a living body is incessant, and in proportion as life is more active, so is decay; but while with the waste of a dead thing there is no corresponding repair, in the case of the living, destruction and renewal advance side by side." (Kirke.)

In relation to that most characteristic of all the manifestations of *vitality*, namely, *nutrition*, it is not possible to form any definite ideas of the processes going on, without the recognition of *destruction* as one, and a very important one, of the series. In a superficial survey of the subject, specially that portion of it which we designate as *growth*, in a young and healthy individual, we may readily overlook this destruction through the excess of the results of formative action; but not so in the maintenance of health in the adult, and still less in the *perversions of nutrition*, to which we give the names of diseases, manifesting themselves at all periods of life. And when we enter into minutiæ, we are compelled to admit that even in the formation of tissue *destruction* is an essential, as a *source of force*, for modern science teaches that such force can only be at the expense of other products. And whether we pursue this

subject in the vegetable or animal kingdom, or as it relates to both, we find unmistakable evidence of this being the case. The plant reduces the carbonic acid and water on which it has to live, and the animal feeding, either directly or indirectly, on the plant, brings the carbon and hydrogen, which had been separated from the oxygen by the plant in its growth, into contact again with oxygen, and the carbonic acid and water are again produced. Animal heat is one of the consequences of this contact. Combustion has occurred, and "save as regards intensity, there is no difference," we are now taught, "between the combustion that thus goes on within us, and that of an ordinary fire." (Tyndale, Lect. xiii, on Heat, p. 507.) So in all other actions in the body, heat, as *one* of their essential products, can only be at the expense of the tissues involved; hence we find the destruction always portioned amongst the various components of those tissues in the order of their facility for *oxidation.* This has been clearly shown by Chossart and Savory, and by Beschoff and Voit, in their observations on death from starvation.

In normal or healthy nutrition, all the materials consumed by oxygen, for heat, motion, or function, are not, however, thoroughly and instantly oxidized, that is, converted at once into carbonic acid, $CO_3 + HO$; but are thrown off by the skin and kidneys, in the form of lactic, formic, and uric acids, &c. It is quite conceivable, as Prof. Odling observes, that in the organism of birds, for instance, an economy of oxygen or breath may be of more importance than an economy of tissue or food.* Indeed, the marvellous adaptation in predatory birds of every supplemental contrivance for increasing ever so slightly their respiratory surface, without, however, departing from its almost reptilian type of structure, is strongly suggestive of those animals being, so to speak, under-lunged, and of the necessity for economizing their lung action in every possible

* "Of all animals birds are most dependent upon a constant renewal of the air in their lungs, and upon the purity of that with which they are supplied. Most birds will die in air which has been but slightly charged with carbonic oxide, and which can be respired by mammals without immediate injury." (Carpenter, p. 758, 3d edit.)

way. Thus we have the ejection from their kidneys of urate of ammonia instead of urea. "In urea, CN_2H_4O, the ratio of nitrogen to carbon is as two to one; whereas, in urate of ammonia, $C_5N_5H_7O_3$, it is as one to one; so that for an equal elimination of nitrogen, the quantity of carbon discharged from the kidneys of birds in the form of urate of ammonia is twice as great as that discharged from the kidneys of mammals in the form of urea." (Odling, Anim. Chem., p. 145.)

Uric acid and its salts are evidently the result of an incomplete oxidation of nitrogenous tissue. Hence, "in accordance with this deduction, we are not surprised to find that the tissue metamorphoses of reptiles, whose motions are so sluggish and temperature is so low, should yield imperfectly burned and used carbonic oxide in the form of uric acid, or rather urate of ammonia, instead of the perfectly burnt and used carb. anhydride excreted by mammals." (Odling, op. cit., p. 141.)

And not only is it to be accepted as true and well proved "that every change in the condition of the organic components of the body, in which their elements enter into new combinations with oxygen, is a source of the development of heat (Carpenter), and that whenever the cooling influence of the atmosphere is greater, or the retrograde metamorphosis of tissue takes place with less activity, some further supply of heat-producing material is required, but also that the cutaneous respiration (as the action of the skin on air has been designated), promotes, in a very important way, those molecular changes on which the maintenance of the heat depends." (Carpenter, p. 625.) The experiments of Becquerel and Breschet (Compt. Rend., Oct., 1841), repeated and confirmed as they have been by Magendie (Gaz. Med., Dec., 1843), and others, have shown that the exclusion from the skin of the atmospheric air, and the consequent prevention of the oxygen from that source exerting its influence there, had the effect of producing a most rapid reduction in the temperature of the whole body. Their mode of experimenting was to cover rabbits (previously shaved) with a composition of glue, suet, and resin, which formed a coating impermeable to the air, and although such a coating necessarily offered a most complete obstruction to the ordinary evaporation from the surface by the sweat, and

reduction of temperature in that way, still its effects were so prompt that in the first rabbit, which had a temperature of 100° before being shaved and plastered, the thermometer had fallen to 89½° by the time the material spread over him was dry. An hour after, the thermometer placed in the same part (the muscles of the thigh and chest), had descended to 76°. In another rabbit, prepared with more care, by the time that the plaster was dry the temperature of the body was not more than 5½° above that of the surrounding medium, which was at that time 69½°. "These experiments," as Dr. Carpenter truly observes, "place in a very striking point of view the importance of the cutaneous surface as a respiratory organ." (p. 625.) Reignault and Reiset have attempted to estimate the amount of carbonic acid exhaled from the skin of warm-blooded animals, and set it down as about $\frac{1}{50}$th of that furnished by the pulmonary respiration. Dr. Edward Smith's calculation is somewhat less than this. But, as Kirke remarks (Physiol., p. 439), "the respiratory function of the skin is, perhaps, even more considerable in the higher animals than appears to be the case from the experiments of Reignault and Reiset just alluded to," for Magendie, in his experiments with the impermeable varnish, got a reduction sometimes as much as 36° Fahrenheit, below the ordinary standard of the body experimented on.

The most important constituent of blood-serum, its *albumen*, has been long recognized as the raw material from which all the other protean bodies, and probably all the nitrogenous tissues, are elaborated, and Lehmann not only has shown (vol. i, p. 332) that many modifications in the properties of albumen depend upon the different quantity of alkali or salts which it contains, whilst the organic group of atoms in the albumen has always (vol. ii, p. 207) remained the same, but also most emphatically declares the differences in the albumen depending upon an augmentation or diminution of the quantity of alkali, that is to say, neutral basic and acid albuminates of soda occur even in the normal condition, as, for instance, in the blood of different vessels. It probably exists in an acid condition in casein.

"Fat exists in the serum chiefly as stearates, margarates, and

oleates, but not in a phosphorized form as we meet with it in the blood-corpuscles. Becquerel and Rodier have shown that the quantity of fat in the blood-serum is increased at the beginning of every acute disease. The undefined substances called by chemists extractive matters, are found in the serum in variable quantities; the variation in this respect has, however, been shown by Nasse and others to be due to the rapidity and extent of the metamorphosis of the tissues. The blood of the hepatic veins is said to contain more than that of the portal vein, and the latter more than that of the jugular. Amongst these so-called extractive matters there are thus far enumerated sugar, creatine, creatinine, hippuric, formic, acetic, and lactic acids. That formic and lactic acids exist in the blood has been thought obvious from the fact that the sweat contains an abundance of the former, and the muscles of the latter. They have all been found on the splenic vein." (Day.)

Arterial serum is somewhat richer in salts than venous serum. In severe inflammatory affections, and especially in cholera, the saline constituents of the serum are much diminished, while in the acute exanthemata, in typhus dysentery, malignant intermittent fevers, scurvy, Bright's disease, and in all varieties of dropsy and hydræmia, they are considerably increased. In the instance of cholera the blood-cells also suffer a loss of their saline constituents, and we have there a positive demonstration of reaction between the two. The serum reacting on the blood-cells abstracts not only a portion of their water, but also a portion of their salts, but as the potash compounds and the phosphates predominate in the blood-cells, it is these salts which chiefly escape into the plasma; consequently, as Lehmann remarks, these compounds are more abundant in the serum in cholera than in a state of health, and hence also in cholera the blood-corpuscles become relatively richer in solid organic matters, while they lose a portion of their soluble salts. (Op. cit., vol. ii, p. 236.) In all these we have well-defined chemical changes, and in them the active part which oxygen takes is to be readily recognized.

The method adopted by Prof. Beale of demonstrating that the *formed material* of cells and corpuscles is perfectly passive in the process of increase and multiplication, shows not only

that osmosis, by which our tissues live on the *pabulum* surrounding them, is attended by *chemical* changes, but that the intensity of the vital action going on within them is intimately associated with *acidity* there. His method was that of putting *growing* material in an *ammoniacal* solution of carmine. This solution passing through without affecting the *formed* material, has its coloring matter precipitated in the interior by the *acid* there combining with the *ammonia*. "Tones of color of different intensity are often," he says, "observed in a cell colored by the carmine; the outermost or oldest, or that part which is losing its vital powers and becoming converted into formed material being very slightly colored; the most central part, or the nucleus, although farthest from the coloring solution, exhibiting the greatest intensity of color." (Protoplasm, p. 47.) Prof. Beale, also (p. 46), says: "Nuclei and nucleoli are always more intensely colored by alkaline coloring matters than other parts of the living germinal matter, a fact which is alone sufficient to show the difference between a true nucleus or new centre and an oil-globule, which has often been wrongly termed a nucleus." This fatty matter found within the cell or corpuscle is likewise considered to be *formed* material, as Prof. Beale says, of a *secondary character;* for when the pure germinal matter is exposed to oxidizing influences, the conversion of germinal matter takes place partly into the cell-wall proper, and partly into the secondary formed material or oil. (Tyson, Cell Doctrine, p. 82.)

In the blood we not only find the *liquor sanguinis* with an *alkaline* reaction, and the contents of its corpuscles *positively* acid, but we learn from the researches of Schmidt and Lehmann the existence of positive differences in the chemical characters of the constituents of the two, and of the want of similarity in the proportions of those salts which are common to both.

"In addition to acid phosphates or conjugated phosphoric acids, Lehmann infers that the blood-cells must likewise contain a nitrogenous noncrystallizable acid; for if the crystalline substance of the blood be coagulated by heat from its watery solution, the filtered fluid has an acid reaction, and in addition to acid earthy phosphates contains this acid, whose characters are, that it is not crystallizable, that it reddens litmus, that

with bases it forms salts which are soluble in water, and for the most part in alcohol, and that on heating it develops a gelatin-like odor, and leaves a bulky carbonaecous residue difficult of combustion." (Day, p. 217.) Schmidt has shown "that the fluid of the blood-cells (that is to say, the water contained in the blood-corpuscles), contains in addition to organic matters a great preponderance of (acid) phosphates, and potash salts, the quantity of the latter being such in relation to that found in the blood as an entity, as to justify the inference that the phosphate of potash and the greater part of the chloride of potassium belong to the blood-cells, while the chloride of sodium, with a little chloride of potassium and phosphate of soda, belong to the plasma. In the latter the organic matters are combined solely with soda, while in the blood-cells the fatty acids and the hæmato-globulin are associated with potash as well as with soda." These results of Schmidt have been confirmed by Weber. (Pogg. Ann., 1850, pp. 99, 115, vol. lxxxi.) The corpuscles of arterial blood are invariably richer in salts than those of venous blood. "The iron of the blood pertains almost solely to the hæmatin of the blood-cells, and so the gases, carbonic acid, nitrogen, and oxygen."

Odling observes, that "if we treat the more complex members of our series of fatty acids, for instance, with powerful oxidizing agents, we obtain bodies in which the number of the constituent atoms of hydrogen and carbon becomes progressively less and less, until we arrive at bodies containing only two, and finally at bodies containing only one carbon atom. In some cases, these successive oxidation products are found to contain the same number of atoms of oxygen as the bodies from which they were produced, though in a majority of instances they contain a greater number, and consequently belong to more oxygenized series. But whether they contain the same or a greater number of oxygen atoms, we find the number of their atoms of carbon and hydrogen become gradually less and less than molecules pertaining to simpler and simpler groupings.

"The tendency of oxidation is to separate the constituent carbon and hydrogen atoms from one another, until at last there is left only the most stable mono-carbon compound

known to chemists, namely carbonic anhydride, or, as it is frequently called, carbonic acid." (Odling.) "No matter what the complexity of the original molecule, the chemist eventually succeeds in transforming it by oxidation, through a series of less and less complex molecules into carb. anhydride, or oxide of carbon, on the one hand, and water or oxide of hydrogen on the other—the identical bodies out of which the vegetable organism directly, and the animal organism indirectly, builds up those complex bodies which we have designated proximate organic principles." As was observed by Gerhardt some twenty years ago: "One of the two extremities of the scale of organic compounds is occupied by albumen, and gelatine, and fat, and cerebral matter; the other extremity by carbonic acid, and water, and ammonia; while an infinity of bodies are included in the interval. The chemist, by treating the superior substances with oxidizing agents, gradually descends the scale of complexity, converting these substances into more and more simple products, by successively burning off a portion of their carbon and hydrogen."

"Thus, then, we have presented to us one important aspect of organic chemistry, namely, its analytic or destructive aspect; that aspect upon which, until of late years, the attention of chemists was almost exclusively directed; that aspect, indeed, which was at one time considered to be the only possible aspect that could ever be presented." To quote again from the same distinguished chemist, of whom, says Prof. Odling, I am always proud to avow myself a pupil: "I show," said Gerhardt, writing in 1842, "how the chemist does everything that is contrary to living nature; that he burns, destroys, works by analysis; the vital force alone operates by synthesis, and reconstructs the edifice destroyed by chemical forces."

Even Virchow cherishes, as he says, "the conviction that particular substances which find their way into the blood are able to induce particular changes in individual parts of the body by then being taken up into them in virtue of the specific attraction of individual parts for individual substances." (Virchow Cellular Path., p. 158.) And this great expounder of the cell-doctrine admits, in the opening of his lecture on the blood, in the most positive manner, that the deviations in

some of the dyscrasias are, if not essentially, more of a *chemical* than of a *morphological* character, and are seated in the fluid constituents of the blood.

The chemical character of the cell changes has also been proclaimed by Strecher, who not only declares "that we cannot conceive, even for such a minute structure as the primitive cell, any functional process to take place without the occurrence of chemical processes;" but also that "in the only direct observations we have in regard to the metamorphosis of tissue in the living cell, that by Kuhne (Max Schultze, Arch. Bund, II), we have positive evidence of such action being intimately connected with one of consumption of oxygen."

But with all the evidence (and recognition) of several processes of oxidation going on in our bodies we have the same for the occurrence of deoxidation. Lehmann declares "the fact that the fats and liquids which are first formed in the animal body can only be produced by a process of deoxidation," and "we can scarcely," he says, "refer cystine, which is so rich in sulphur, to any other source than a process of deoxidation, whilst the great amount of sulphur present in many horny tissues, which contain a perfectly identical group of atoms with albumen, can hardly be ascribed to any cause but a mere local deoxidation." (Ib., vol. iii, p. 206.) Again, "We know," says Prof. Odling, "that in certain proximate principles of food the oxidation of some of their constituents is effected at the expense of the remainder, which consequently become deoxidized, and it is possible that some animal products may have undergone an entire deoxidation, or even several alternate deoxidations and reoxidations before their final discharge from the body." (Anim. Chem., p. 80.)

Indeed it would appear from a careful consideration of the chemistry of all organic life, that whilst the development of heat or motion or function or the like is the result of oxidation of material, the reverse, deoxidation, must be the source of the maintenance or growth of a body, for the former are the result of the liberation within the body of force which had been rendered latent there by the latter. "But," as Prof. Odling observes, "whilst nutrition or the storing up of force constitutes the chief action of vegetable life, in animal life it occupies an

altogether subordinate position. For the prime characteristic of animality is activity, the employment of pent-up force in the production of external acts. Hence while in the vegetable and animal organisms deoxidizing and oxidizing processes, constructive and destructive actions, alike take place, in the vegetable the destructive are subordinate to the constructive, whilst in animals the constructive are subordinate to the destructive acts." (p. 77.)

To comprehend the part thus performed by oxygen we have to consider the states in which it is in our systems. "The view maintained by Magnus, that this gas enters into no chemical combinations with the constituents of the blood, either in passing to or from the tissues of the body, but forms merely a physical mixture with the circulating fluid, is no longer accepted by chemists." (Carpenter.) "Lehmann has shown that only from $\frac{1}{14}$th to $\frac{1}{11}$th of the oxygen which is absorbed by the blood can be absorbed mechanically, that is to say by the water, or can consequently exist free in the blood; the large amount of remaining oxygen ($\frac{10}{11}$ths at the lowest calculation) must be fixed by the blood-cells through the agency of some chemical attraction." (Day.) "Pettenkoffer and Voit state that from 94 to 98 per cent. of the oxygen absorbed in twenty-four hours is eliminated in the form of carbonic acid from the lungs." (Carpenter.)

It is established with equally great certainty that this conversion of materials into carbonic acid is not accomplished by one abrupt and instantaneous destruction in the capillaries, but goes on by a series of oxidations, which beginning at the point where the carbon existed as tissue is not completed often until the blood reaches the right side of the heart.

"The scarlet color of the arterial blood has been supposed by some observers, and for some reasons, to be due to the chemical action of oxygen, and the purple tint of that in the veins to the action of carbonic acid." There are also "facts which make it seem probable that the cause was a mechanical one rather than a chemical, and that it depended on a difference in the shape of the red corpuscles, by which their power of transmitting and reflecting light was altered." We believe, however, as

Kirke says, that Prof. Stokes has at least for the present set the vexed question at rest.

"From the results of spectrum analysis, he has been led to the conclusion that the coloring matter of the blood is capable of existing in two different states of oxidation, and that the respective colors of arterial and venous blood are caused by differences of tint between these two varieties, scarlet cruorin and purple cruorin. The change of color produced by the passage of the blood through the lungs, and its consequent exposure to oxygen, is due probably to the oxidation of purple cruorin and its conversion into scarlet cruorin, while the readiness with which the latter is deoxidized offers a reasonable explanation of the change in regard to tint of arterial into venous blood." (Kirke, p. 94.)

Schonbein has long since declared that the red corpuscles act as ozoniferous bodies, whereas the serum has no influence on the reagents, which are indicative of the presence of oxygen in such a state. And not only does Demarquay (Essai de Pneumatology) state that all recent facts prove indeed that a part of the oxygen combined with the globules offers the modification which we call active oxygen or ozone, but Lehmann, evidently unwilling to accept some of Schonbein's modes of explanation, and the conclusions he deduces from his discoveries, says that it is almost a necessary deduction from his most recent observations, that the oxygen in the blood must undergo a change resembling that which it experiences when retained for some time in intimate contact with phosphorus, oil of turpentine, &c.

The most recent researches of Von Gorup Besanez (Ann. de Chem., vol. cx, p. 86–107), would indeed seem to leave no doubt that it is in its ozonized state that oxygen does its part in the *formative* action of cell-life, and the chemical differences already shown to exist between arterial and venous bloods made it quite plausible that the healthy exudation from the former, in contradistinction to that from the latter, carries with it oxygen in the ozonized state. The cruorin which has been the carrier of such oxygen certainly does not escape with the lymph from the arterial radicles, but parts with that distinctive quality of oxygen at that point, and we have before

seen that ozonized oxygen in passing from the chemical combined to the free state can act as a deoxidizer, hence the changes effected by the oxygen from arterial blood can be *passively* constructive as well as actively destructive in their characters, so that without begging for oxygen any other properties whilst in our system than is accorded to it in the world around us, we can readily explain the results which are universally attributed to it.

What we have now seen to be going on as regards oxidation in our living tissues, when in health, is equally true of them, and still more evident, when they are the subject of inflammatory action, and their sequences. "Indeed we are now taught that inflammation, suppuration, ulceration, &c., are not as they used to be thought, something *distinct and isolable added* to what is going on in a living tissue, but that they are perversions of such processes, or perhaps, to speak more accurately, they are the manifestations of abnormal products of such processes, for although pathologists have been accustomed to look for the proximate cause of the phenomena which essentially constitute the inflammatory state, or in other words, for the first departure from the normal course of vital action, in the enlarged or contracted dimensions of the bloodvessels of the inflamed part, or in the altered rate of movement of the blood through them, yet it may now be safely affirmed that these are only secondary alterations, depending upon an original and essential perversion of that normal reaction between the blood and the tissues which constitutes the proper nutritive process." (Carpenter.) Mr. John Simon, one of the most recent authorities on the subject says, "As regards the difference between these actions (formative and destructive), when they occur in health, and when they occur in inflammation, it may suffice to observe, empirically, that the *appreciability* of the *opposed results* is in itself a differential mark of inflammation. In healthy tissues, during their normal self-mutation, the anatomist does not at any given moment find either palpable detritus to express their waste of material, or multiplying embryonic forms to express their action of repair. The change of matter, the degeneration and removal of what is effete, and the substitution of what is useful, occur there so evenly and proportion-

ately, that separate steps are not marked in the process, nor can any contrast be found between the respective elements of declining and nascent tissue. But in inflamed parts, as has been said, these manifestations are made. A more or less considerable rubbish of old texture, and a more or less considerable germination of new forms; these, side by side, and in contrast, are pathognomonic in the anatomy of inflammation." The grounds which Mr. S. gives of this generalization are well worth our careful study. He truly remarks that the forms of inflammatory destruction are less different than the superficial observer might believe. And not only is it the case, that pathologically they cannot be separated, but practically also it is found that those of them which to the common eye seem most disorganizing and mutilative, cannot complete themselves unless the so-called other forms coexist and co-operate with them."

"First, there is *gangrene;* the death of a bit of body, and its abandonment to the same sort of changes as it might undergo in the dissecting-room. These changes are unmixedly chemical. Of necessity, they express themselves less in the comparatively unperishing material of bone, than in the rapidly putrefying soft textures of the body. In the latter textures, they proceed like common cadaveric putridity; proportioning themselves to local conditions of succulence and temperature, and giving, of course, different products according to the chemistry of the material which rots. Whoever knows what changes occur in an element of the body separated from the rest, and kept macerating at temperatures of 60°–100° F., can predict what changes the same element would undergo if gangrenized in connection with the body."

"As regards the different amounts in which inflammation may produce gangrene, the student must remember that, in the sense of our present discussion, great gangrenes, such as are witnessed in the necrosis of masses of bone, or in the sphacelation of entire limbs, are extreme instances at one end of a very extensive scale; that, pathologically, there are many illustrations of gangrene, to which, surgically, the word is not applied; that in the formation of any common blister, for instance, the raised cuticle consists of material irrecover-

ably dead; and that every epithelial desquamation is in fact the shedding of an epithelial slough."

"Secondly, there is *ulceration*, a process which differs from *gangrene*, mainly in the fact that it proceeds more gradually and molecularly. At a place where an ulcer exists, the absent texture perished as truly as by gangrene; but while gangrene would have occasioned its abrupt separation in mass, ulceration permitted its progressive shedding as detritus. The discharge from any spreading ulcer, if examined under the microscope, invariably exhibits particles of disintegrating tissue, and the so-called 'foulness' of an ulcer is but gangrene on a small scale.

"Thirdly, there is *liquefaction*, the process by which the covered-in textures of the body are enabled to waste away their material, just as by ulceration the surface textures can waste away theirs; a process which, without making any surface-gap in the body, can fuse away so much material that the affected organ is left excavated, attenuated, or scarred; a process which, like ulceration, begins as a process of softening, and differs from ulceration only in its more complete disorganizingness, for the perishing tissue (having no vent but through the blood) cannot be shed in sensible particles, and therefore must be so absolutely disintegrated and fluidized as to be capable of soaking through the membrane of the capillary blood-vessels."

"And thus the destructive acts of inflammation form, in their several kinds and degrees, one long series, which, with no sudden breaks or contrasts in it, extends from the confines of normal texture waste to the utmost excesses of gangrene. For assuredly the common changes of material which attend every vital action—the changes which permit certain elements of every used texture to pass away effete from the rest, are changes which include liquefaction; and inflammatory softening may be traced up in successively finer manifestations, till at last it confounds itself with these changes. Healthy waste of texture leaves, we repeat, no perceptible detritus. As the working texture molecularly perishes, so molecularly it melts away. Getting thus continuously freed from all worn-out material, it has no local rubbish heap to show, no lot of super-

seded decomposing particles. But as we descend from the confines of health, we lose this clean perfection of result. Step by step within the regions of marked disease, we find an increasing crudity of waste product. Tissue is destroyed in inflammation quicker than it can be dissolved and removed. Refuse materials, with more or less trace of texture remaining in them, can be perceived with the microscope, perhaps even with the naked eye. These are the particles which characterize the discharge of spreading ulceration, and which, with the softening of any covered-in organ, constitute, till gradually their liquefaction is completed, the pathological link between softening and ulceration. In what the surgeon commonly recognizes as gangrene, the essential fact stands out, of course, most conspicuous,—inflammation has suddenly killed a mass of organic substance (say a foot or a tonsil), not punctatively, so that dead particles are interspersed amid living particles, but with a uniform death in its entire solidity. And now, what becomes of this killed bit of body? Something of it liquefies, and where nearest to living capillaries, passes, as in common softening, into the circulation. Something of it breaks off in shreds, and where nearest to the surface of the body, is discharged as though it were the shedding of ulceration; but the bulk is too solid to be thus disintegrated in its entirety; and when, by ulceration and liquefaction, its circumferential parts are loosened from living contiguous tissues, it drops off, as something with which the body has no further concern, to complete its decomposition at a distance."

Furthermore, "the *phenomena* of inflammation are modified phenomena of textural life. The modification is primarily one of quantity; the phenomena are in excess, but, because of their excess, they tend to be unelaborated and crude; change of material is striven for more rapidly than normal change can complete itself.

"This excess, but incompleteness, of textural change shows itself anatomically in two concurrent signs; one belonging to the category of textural decay, the other to the category of textural renovation.

"On the one hand there is effete material, unremoved material, disappropriated and brought to death quicker than it can

impalpably melt away, hence 'sloughs,' and 'desquamations,' and 'debris,' and 'softened' and 'degenerated' tissue.

"On the other hand there are nascent forms unapplied, forms which express a profuse but unconsummated textural growth, forms which have resulted from intratextural germination, but have either perished before maturity, or have definitely ripened into mere abortions of texture, hence 'irritative hypertrophy,' and 'degenerating endogenies,' and 'inflammation-corpuscles,' and 'mucus-corpuscles,' and 'pus.'

"The action whereby inflammation begins is one which physiologically cannot be distinguished from hypertrophy. The line of distinction is drawn where the effort of hypertrophy becomes abortive, and where the forms of increased growth are mixed with palpable refuse of increased decay.

"From simple autopathies of texture, inflammation is distinguished by its compoundness; simple hypertrophy does not evolve profuse waste products of degeneration; simple degeneration does not provoke an excessive textural productivity; it is the union of such opposites which makes the diagram of inflammation.

"Cancer and inflammation have the most intimate morphological affinity, and probably what is distinctive of cancer lies far less in the nature of its textural phenomena, than in the hitherto unknown causes which give them their fatally continuous progress."

"With the hypertrophic textural changes which are introductory to inflammation there is invariably, though as yet latently, an increased textural waste; as cells begin to germinate intercellular material begins to pass away. Tested, however, by visible forms, the hypertrophy always seems to spread more widely than the waste; and there are cases where inflammatory loss of substance, and inflammatory reproduction, though concurrent and correlative, seem abruptly set apart in different zones of texture.

"The inflamed part, with its increased textural change, is increasedly productive of heat. Through its veins and lymphatics it increasedly contributes to the circulating blood both heat and changing material."

"Inflammation determines hyperæmia. When the textural

changes begin, the elements become increasedly absorbent of blastema, and suck more than commonly from the capillary circulation; hence 'effusion' or 'exudation' into or on to an inflamed texture; hence also the 'stasis' of corpuscles within any capillary channel which is thus deprived of its succor. To provide, during local necessity, for this greater local appropriation of blastema, greater afflux of blood is required; in inflammation (as in simple hypertrophy), the ministerial blood-vessels accordingly dilate, and ampler supplies are transmitted through them."

"Inflammatory 'effusions' are derived, not indifferently, but electively, from the blood; the inflamed texture appropriating in excess those chemical ingredients which it requires for its germination."

"The so-called 'form symptoms of inflammation' are such signs as can during life be best perceived, of increased textural change: *heat*, as its necessary concomitant; *redness* and *swelling*, as the expressions of attendant circulatory and transudatory changes; *pain*, as the measure of nerve injury subsisting in the local process. Further essential symptoms may be produced, primarily by the *functional excitement*, subsequently by the *functional inaction* of the particular organ inflamed."

"Inflammatory excitement tends to diffuse itself within limits hitherto not defined; inflammations, both common and specific, are communicable from part to part, and from person to person. 'Sympathetic inflammations' are facts of inflammatory contagion. 'Inflammatory fever' is a total bodily infection wrought by materials from the inflamed part.

"Inflammatory fever consists in an unduly hot and changeful state, primarily of the blood, secondarily of all blood-supplied textures. The symptoms of inflammatory fever are the signs of this greater heat and change."

"Inflammatory excitement may be caused by the excess of any influence which, in minor operations, would healthily increase, or healthily diminish, the acts of textural life. In either case (whether of over-stimulation, or of over-depression), the primary effect is that textural death is produced. And textural death, whatever may have been its cause, is necessarily a starting-point for inflammation."

"Influences which respectively can stimulate or can depress textural life are (so far as we know them), powers which respectively can promote the chemical change, or can give fixity to the chemical constitution of textures on which they operate."

"Textural predisposition to inflame is a form of vital mobility in the texture, a form which probably in every case corresponds to conditions of chemical mobility in the texture."

Inflammation is, of course, in all respects, commensurate with its causes. In proportion as they are long-lasting or recurrent, so is it chronic or relapsing; in proportion as they cease to operate, so do its destructive processes arrest themselves; degeneration becoming confined to superfluities which have to waste away, and production with lessened rapidity, conforming itself to services of repair. In proportion as textural predisposition is extensive or intense, inflammation spreads more diffusely from the part where its determining cause first operated, or wreaks itself on that part with more destructiveness.

The power which produces the phenomena of inflammation is the power which produces the ordinary phenomena of textural life; and fully to explain inflammation would in fact be to explain life.

Finally, the laws which regulate inflammation regulate all other diseases, and the illustrations here given of them lie all within the terms of those few large generalizations which increasing experience tends more and more to establish as the basis of scientific medicine.

"That morbid phenomena, in proportion as they are vital in their kind, consist in merely quantitative or gradative excesses or deficiencies of normal growth or junction."

"That all residual phenomena of disease express the supremacy of physical influences, to which the affected bodily material is more or less passively surrounded, and by which its natural decay is quickened, retarded, or modified."

"That influences, directly causative or contra-causative of disease, cannot produce results otherwise than under these conditions; cannot primarily do more than increase or diminish, in whatever active texture they affect, the texture's typical doing, formative, or functional; cannot primarily do more

than qualify, in whatever passive organic material they affect, the material's passive transformation." (Holmes's Surgery, p. 90–93, vol. i.)

Furthermore as regards the action of the vessels we now know that

"The muscular substance of arteries and veins contracts under the same common stimulants as provoke contraction in the fibres of the dartos, or of the bladder, or of the intestinal canal." "Here then it would appear is the limit of what can be done by the 'action' of bloodvessels. The only 'action' which an artery or a vein is capable (beyond what relates to its own growth and development), is the action of its muscular substance. That action is *contractility*, *regulation of calibre*. In proportion as it is heightened the vessel becomes smaller; in proportion as it is lowered, the vessel becomes larger. In other words, an artery, by its 'increased action,' can only effect a lessened access of blood to the parts which it supplies, and an augmented afflux of blood so far as it depends on the artery can only depend on that artery being in a state of 'diminished action.'"

"This enlargement and filling of vessels is not only arterial. Any one who observes an inflamed part can see that its veins, like its arteries, are large and full."

"This hyperæmia invariably attends inflammation, and is an essential to the inflammatory process. But it is not peculiar to parts which are inflamed."

"A part does not inflame because it receives more blood; it receives more blood because it is inflamed. With the greater necessities of a part, all required blood-supply comes to it;" and the enlargement of bloodvessels which permits this afflux is due not to any mechanism acting *a tergo*, but to an influence primarily exerted by the part. "That in most considerable inflammations of vascular textures there is more or less destruction of capillary bloodvessels, is a fact which may be ascertained in the course of common clinical and post-mortem observations; but the minute circulatory changes which belong to the first onset of inflammation can only be learnt from experiments in the lower animals, best of all by observing the phenomena which result when some mild irritant is applied to

the web of the frog's foot. Every one who has watched in this transparent part the beautiful phenomena of healthy circulation, knows that naturally in the capillaries the corpuscles of the blood do not seem uniformly diffused in the liquor sanguinis, but flow in a comparatively dense series in the middle of each current, and that the marginal parts of the stream consist of liquor sanguinis almost entirely without corpuscles. When the web is artificially irritated (as for instance by a little capsicum or mustard placed on it near its free margin), the blood within the capillaries of the affected area is observed gradually to lose that characteristic appearance; the central stream of blood-corpuscles becomes wider; the marginal stream of liquor sanguinis becomes narrower; the whole stream gets to look (what the mid-stream only ought to look), chiefly corpuscular. With this seeming change in the local constitution of the blood there has arisen also a change in its rate of movement; for a moment, at the first impression of the irritant, the blood seemed to run more quickly, but in proportion as the stream has become corpuscular it has become slow. The changes still advance; capillary streams looking densely and redly corpuscular, are seen moving in the most sluggish and interrupted manner, till eventually stagnation arises. The corpuscles are now so packed together that individual forms are no longer distinguishable. Groups of capillaries, thus plugged by motionless solid seeming contents, look as though they were converted into a non-tubular coralline network, and this is the state which, since it was first pointed out some forty years ago, has been familiarly known to pathological observers as the capillary 'stasis,' producible by irritation."

"Our knowledge of these phenomena is derived almost exclusively from experiments performed on the web of the frog's foot; but there are good reasons for believing that the capillary circulation of inflamed parts in mammals presents quite similar changes, and the knowledge, such as it is, may be summed up in the following conclusions:

"That within the area of stasis the blood has lost the fluid in which its corpuscles should float.

"That within the same area the circulation of corpuscles is delayed, the corpuscles tending to rest against the wall of their

containing capillary, and tending also to aggregate there as though by mutual cohesiveness.

"That though the corpuscles when thus *in situ* show a morbid cohesiveness, they do not when removed from the area of stasis seem more cohesive than in blood taken from healthy parts.

"That the circumstances under which inflammatory stasis occurs are circumstances under which there is increased infiltration of the contiguous texture, and that stasis occurs with more or less facility in proportion as the liquor sanguinis is more or less transudable.

"That stasis does not result from alteration of calibre in the afferent or efferent vessels of the part.

"That the cause of its production lies wholly in an influence exerted on the blood by textures within the area of stasis; for it may be produced in the webs of limbs which by strangulation or even amputation are cut off from all dependence on the general system.

"That this influence is, mechanically speaking, of a suctional kind; for when irritation experiments are performed on the webs of a strangulated limb the corpuscles can be seen gathering from both directions (arterial and venous) towards the area where stasis is being developed.

"That this influence is but different in degree from that which the textures naturally exercise on the blood as it passes amid them; for if a limb be temporarily strangulated there arises in its webs within four to eight hours, without any irritant being applied, a stasis which is identical with inflammatory stasis, except that, even after sixty hours' duration, it will be dissipated as soon as the circulation is set free."

Many of the above stated facts contribute to establish that the phenonena of inflammatory turgescence are primarily the result of an increased *attraction* which the inflaming tissue exerts, as it were suctionally, on the blood coursing within its capillaries. This doctrine is not new; it was probably held by Haller, it was Prochaska's (Quest. Physiol., ed. 1778, p. 17), and Hebenstreet (De Turgore Vetali, 1795, p. 25), Burdach (Physiol., iv, p. 422), and even Alison in 1833 (Outlines of Physiol., pp. 422–441), all entertained such or similar views.

"And to persons well informed in vegetable physiology it will certainly not seem strange, for in the vegetable kingdom that sort of attraction is a sufficiently familiar fact. It is thus that certain vegetable textures are able when irritated to undergo such changes of dimension as determine, for instance, the definite movements of the berberis and the mimosa. Thus likewise it is, that under the partial application of stimulants to sections of the vegetable organism, partial growth-phenomena are initiated, and. as it were, hypertrophically sustained. The southward side of a tree will have ripe fruit even while its northward side is still flowering (Times, Oct. 23d, 1834), and if in the winter-time the branch of a vine be introduced into a hot house, it will produce a luxuriant crop of leaves, blossom and fruit even during a frost, in which situation the roots would have been in a torpid state had it not been for the sympathetic influence of the parts above ground brought into action by warmth." (Blane, Med. Logic, 3d ed., p. 154.) "If in the vegetable organism where neither nerves nor contractile bloodvessels exist local derivations of fluid are to this extent possible, there is no reason to wonder that similar derivations are in the animal organism primarily independent of vascular innervation and vascular contractility. The growing elements of the part hurt by physical violence, or affected by extremes of temperature, or thrown into rapid chemical changes, or overburdened with their own specific stimuli from the blood, strive to grow more, or to grow otherwise than in their previous state. The sudden origination of this effort, acting at first independently of the vital endowments of the artery, acting as though a vortex, established in place of the irritant, were causing all streamlets of blood more quickly to approach and more slowly to leave it, suffices apparently in itself to derange the currents of the capillary circulation, to flood the tissue with serous exudation, and to lead to those microscopical phenomena of stasis which are considered pathognomonic of inflammation."

"The investigations made by Dr. Ryneck would seem to demonstrate beyond all cavil or doubt that it is the chemical relations between the vessels or their surroundings and their contents which occasion the stasis and exudation of inflammation. Thus he not only showed that such phenomena would

occur by local irritation in the web of a frog, in whom he had injected milk or defibrinated blood so as to take the place of its own blood—the capillaries becoming choked with the milk-globules or the defibrinated blood just as they would under the same irritation with its normal fluid circulating through them—but he also showed that by first filling the vessels through the circulation with some fluid, like a solution of common salt, to remove the blood from them, then subjecting their interior to the action of some such chemical agent as sulphate of copper, chromic acid, &c., in weak solution, as would modify the condition of their surfaces, and then finally replacing it by the milk or blood, no stasis or exudation occurred." (Rollet's Untersuch aus dem Instit. in Graz, Leipsic, 1870, p. 103.)

"The so-called blastema, or fluid transuded through the walls of the capillary bloodvessels, in cases of venous obstruction, besides increasing in quantity (so as to constitute the well-known phenomena of passive dropsy), presents certain changes of quality—changes which, in proportion as the pressure is great, bring it nearer and nearer to the characters of liquor sanguinis. It gets to contain more and more albumen; it even furnishes a fibrinous coagulum." (J. Simons.) In the so-called effusions or exudations of inflammation, we have "far more albumen than in transudations; the phosphates and potassium compounds are also in excess." (Day, p. 385.) Then there often are in these effusions characteristic cells to be found, "cells of which the pus-cell is the type." "Up to that type there are visible stages of development, and from that type there are visible stages of degeneration; on the one hand immaturities, on the other hand senilities of the product; the former chiefly represented by cytoblasts, and by cells so small that the distinction of nucleus and cell-membrane is only just distinguishable in them; the latter chiefly represented by cells, which become larger and more filled with oil-drops in proportion as they become ready for dissolution. This cell is insusceptible of ulterior development. It may remain long stationary, but it cannot contribute to tissue. It can only degenerate and decay. And its morphological meaning assuredly is, that it represents the miscarriage of what was intended to be texture. The local germination has been excessive, and (in proportion

to various circumstances which will hereafter be considered) parts of it digress into this sterile course of development."

"These, then, generally, are the changes which characterize the blastema of an inflamed part: 1, it is in most cases demonstrably, in other cases presumably, increased in quantity; 2, it contains far more solid matter, both albuminous and saline, than is normal to it; and besides presenting these features, which may to some extent be attributed to mechanical influences, it gives evidence, by the chemical and microscopical characters which have last been described, 3, that specific chemical affinities are exerted in the part; and, 4, that abnormal growth is advancing there.

"In different inflammatory effusions there are differences due to the degree in which the detritus of dead and disintegrating tissue mingles itself with the inflammatory effusion. And not least, there are differences due to the different degrees in which the effusion itself may have undergone degenerative changes, and in proportion as these degenerations occur, the original characters of the effusion give place to others, among which may particularly be mentioned the presence of oil or cholesterin, and eventually of earthy concretions."

"In all these changes the process of inflammatory softening involves something more than the mere deliquescence of tissue. The material which ceases to be consistent does not retain, as if only in a more watery state, its original chemical constitution. In beginning to soften, it also begins to show new ingredients, the results of new combinations of its elements; and the common mark of this chemical change is, that oil-drops, sometimes with other forms of free fat, become, to a greater or less extent, visible in the microscopy of the softening part, so that often, during some stages of the process, fat appears to be the principal residue of texture." The study of this fatty transformation of the albuminous and gelatinous materials of the body, enables us to say that, universally, where this change occurs, its occurrence has the meaning of *degeneration.* And the fact that it habitually forms part of inflammatory changes of texture, would therefore in itself, if there were no other proof, be sufficient to show that inflammation

includes a devitalizing process. Universally, we have said, it denotes degeneration; not simply because fat is of less chemical complexity, is nearer to the inorganic world than albumen or gelatin; not simply because fat, infiltrated through a part, is, so far as we know, incapable of contributing to the mechanical or dynamical usefulness of the part; but further, because the circumstances under which the change occurs, when apart from inflammation, are without exception circumstances which have in them the nature of death. That it occurs to an immense extent in the tissues of the aged, is but an illustration of this truth; it is, so to speak, with a foretaste of death that, as we near the natural end of our lifetime, the heart and arteries, and to a less extent the voluntary muscles and the hard textures undergo this irreparable change. And these facts get their complete intelligibility, when it is further known that fatty transformation occurs abundantly after death; witness the now well-known conversion of dead flesh into adipocere, and Dr. Quain's experimental demonstration, that muscular substance, perfectly healthy at the time of death, will within a few weeks, if kept moist without access of air, assume all the characters of fatty degeneration. (Med. Chir. Transact., vol xxxiii, p. 142.)

To the same effect are the very interesting observations which of late years have been made on the changes which take place in animal matters dead, or with reduced vitality, if they be artificially kept in contact with normal textures of the living body. The question has been raised whether there is true transformation of albumen into oil and residual matter in such cases, or that the albumen as such passed by mere dissolution into the blood, and that the oil was a new substituted, and as it were, secreted material. Dr. Burdach, of Königsburg, found that albumen dried and cased in capsules of collodion would not become greasy within the peritoneal sac, and that bits of elder-pith let lie within the peritoneum so as to be permeated by animal juices would after a while show oil throughout their porous texture; but these interesting results only proved, as Mr. S. remarks, "that access of fluid is necessary for the albumen to become greasy, and that inflammatory effusion,

stagnant within the body, is a dead porous substance into which it has soaked, will itself become greasy." This question seems, however, to be fully answered by certain chemical facts elicited by Dr. Michaelis, for he succeeded in showing with bits of muscle and fibrin that at the same time as these substances were becoming visibly greasy, ammonia was being developed; a demonstration which, by accounting for the nitrogen of the former albuminous compounds, supplied a link hitherto wanting to the argument, and enables us with almost absolute certainty to say, that under the circumstances described, albuminous matters actually undergo decomposition, and leave fat with ammonia in their place. (Ibid.)

A perfectly fresh solution of the most perfect form of the reparative material exhibits, according to Lehmann, all the physical and chemical characters of the intercellular substance of the blood. It contains all the essentials for the production of tissue there, the albumen, fats, carbohydrates, and mineral substances. (Day.) The *quantity* and *quality* of all these can of course be very materially affected by various conditions. Lehmann has found that "the intercellular fluid of the tissues becomes, from this increased activity (which we have seen arises at the outset of inflammation), more and more alkaline, and that *then* the subsequent crops of cells are less and less plastic;" and further he says, "The first principles of chemistry teach us that the tendency of oxygen to combine with certain elements is extraordinarily strengthened by the presence of alkalies." Hence we have at the very first glance a strong impression made on our minds that *increased oxidation* is a most essential factor in the abnormal state of nutrition, which we designate as inflammation; and this impression becomes stronger the further we investigate the subject.

Thus the afflux of blood to an inflamed part, which we have seen occurs because the part is inflamed, and not from any mechanism acting *a tergo*, and is due to an influence primarily exerted in a part, we can trace to this same action of oxygen, for the *increased* oxidation in the inflaming tissue produces from the carbohydrates of that tissue an increased quantity of lactic acid there; and this last-named substance Prof. Graham

has shown causes the diffusion of the lymph, from the blood-vessels sucking it out from the vessels, in the instance of inflammation, with such force as to even reverse the current in the venous radicles. This abstraction of the liquor sanguinis is so rapid as to materially increase the proportion of red corpuscles in the surrounding vessels. The consequent retardation in the flow through those vessels, added to the increased quantity of oxygen in them (from the greater number of red corpuscles), can explain the turbidity of the plasma of the blood long ago noticed as present in inflammatory conditions (Day); and which Scherer and Lehmann have shown was the result of separated albumen, for "as in these cases the serum is only very faintly alkaline, and the turbidity disappears with the addition of a neutral salt, it is most probable that the albuminate of soda in the blood has been deprived of some of its alkali, and that a portion of the albumen thus freed from its soda separates in the molecular form." (Day.) It is certainly not unreasonable to suppose lactic or some kindred acid to be the result of the oxidation which could have place in the vessels themselves under such circumstances. In connection with such oxidation Dr. Parkes suggests a reason for the thirst of fevers. In his Gulstonian Lectures (Medical Times and Gazette, vol. x, p. 333), he remarks: "Is it possible that in fevers some substance is produced which has as powerful an attraction for water as sugar, and the action of which may cause the universal thirst? A fact mentioned to me by Mr. Graham will put my meaning in a clearer light. Mr. Graham has discovered that gelatine has an extraordinary attraction for water, so that it will even take it from alcohol, and render alcohol almost, if not quite, anhydrous. This property, manifested at all temperatures, is particularly marked at the temperature of 98° to 100° F. Albumen, on the other hand, has little attraction for water, and yields it up at once to alcohol. Now supposing that in the rapid metamorphosis of albuminous substances in fever, gelatinous compounds, or something approaching to them, were formed, and this is by no means unlikely, then as a consequence of a physical law the gelatine would at once take water from the albuminous tissues, and

would necessarily give rise to intense thirst. Then, unlike sugar, the gelatinous substance would not be discharged, but must be converted into urea and uric acid, as ordinary gelatine is when it is taken as food."

Bence Jones is most definite in the recognition of these chemical conditions in inflammation. In the opening of his 10th lecture he says: "I shall endeavor to show you that inflammation is a chemical disease, a state of oxidation beyond that which occurs in health, varying in its mechanical results in consequence of the structure of the different textures in which the excessive action is set up." And further:

"When the simplest possible case of inflammation is taken in parts where neither bloodvessels nor nerves exist, then we find that there is a chemical action which is independent and anterior to both the nervous and the vascular action."

In Lecture 11th (on Bright's Disease, p. 201), he says: "The ordinary oxidation which takes place in each texture of the body, gives heat and motion sufficient to carry on the ordinary nutrition of the structure; but the smallest increase of oxidation set up by direct extra vascular, or indirect intra-vascular motion through the nerves, is followed by altered heat, motion, and nutrition."

"The effect of slow but continued peroxidation may be watched, in the skin, or in the eye. Continually, and within the body, mechanical alterations show no less clearly what such increased chemical changes can effect. The slightest long-continued mechanical pressure produces not only thickened cuticle, but altered nutrition of the skin itself; or a slight cut may cause a thickening which may last for months or years, after the slight inflammation which united the surfaces has passed away. So in the cornea, the most chronic inflammation, from some slight mechanical cause, will leave a thickening which may be perceptible for years; or if you look within, you may see the most chronic gout, rheumatism, or scrofulous inflammation, when long continued, slowly cause such an amount of thickening in the joints and other parts, that the utmost mechanical impediment to motion may ultimately result. Of all textures, the cellular texture is the one in which substances pass most immediately from and to the

blood, and in which alterations of oxidation and nutrition are most liable to occur."*

If we may then accept as data, sufficiently well determined to be used in reasoning on the subject, that the destruction of tissue, in both the normal and abnormal states, is one essentially of oxidation, and that their reconstruction, in both healthy and diseased nutrition, is one of deoxidation or hydrogenation of the nutritive material, we cannot have any difficulty in perceiving how the earth could act beneficially on both the conditions of destruction and repair which are peculiar to the morbid states.

We can thus not only find satisfactory explanations in the earth's greed of oxygen and ammonia, and its well-known chemical reaction and powers for the restoration by it to the normal state of the circulation in a part, from that of *stasis*, plugging of the smaller vessels with blood-corpuscles, or sluggishness of the current, which then looks "densely and redly corpuscular," or has a diminished "marginal stream of liquor sanguinis," with the concomitant effects, the development of *mutual cohesiveness* of the blood-corpuscles there, the increased exudation of liquid contents of the vessels occurring evidently under some suctional force, which has power to act so great as even to reverse the natural direction of the current. All of which conditions we have seen are attributed by physiologists to direct chemical reactions between the cells and intercellular fluids of the tissues and bloodvessels, an increased alkalinity exciting oxidation. But such may furnish us with an explana-

* Again, Dr. A. Blatin (Recherches sur la Nicotine et la Tabac, Paris, 1870, page 15), declares:

"La substance capable de reparer les pertes de l'organisme doit étre un principe complexe, quaternaire, ternaire, ou binaire dans le quel les corps qui la composent sont combinés dans un etat favorable a la combustion cest-a dire que certaines proportions doivent exister entre l'azote, l'hydrogene le carbone et l'oxygène. Ainsi par exemple l'urée qui pourtant contient tant d'azote, ne peut devenir un aliment parce qûélle est un dernier degré d'oxydation et que lorsqu 'un corps est saturé d'oxygene il est incapable de nourrir. L'aliment parfait par excellence serait celui qui contiendrait le plus d'azote de carbone, d'hydrogene et le moins d'oxygene possible."

tion of what has heretofore been a mystery to surgeons and pathologists, *the pain of inflammation.* This pain "has been by some ascribed to compression of the nerves of the inflamed part by distended vessels and effusion; by others to an exaltation of nervous function, or to a painful stretching of the nerves, arising from the distension of their small nutritious vessels; and by others to an impression produced on the nervi vasorum by the slight dilatation and elongation of the arteries during each impulse of the blood." (Pirrie, p. 36.) Now the pressure from "distended vessels and effusion," "stretching of the nerves," or by the "slight dilatation and elongation of the arteries," may be a source of pain, but it is not the efficient one of that in inflammation, for although it is true that "usually the intensity of the pain is in the direct ratio of the firmness and unyielding nature of the part affected," it is not always so, for "there is generally more pain in *external* inflammations and in inflammations of the investing membrane than in those which affect the substance of the viscera or mucous membranes," and "the pain is generally greater in common than in speeifie inflammations, with the exception of gout." We also meet "scrofulous inflammations, in which extensive disorganization is often produced without the patient having ever been conscious of actual pain." (Pirrie.) Again, we see acute pain of inflammation often alleviated or allayed by firm methodical compression, and subside when eertaiu changes, which are attended with very much greater swelling than existed when the pain was present, have place.

Under all these circumstances it is evident then that a mere *mechanical* change in the tissues of the part is not *the* source of pain. We all know that the *severity* of the pain in an inflamed part is as a rule directly proportioned to the intensity of that inflamuation, that is, to the degree in whieh the ehanges characteristic of acute inflammation is developed.

If then this inflammation is not "something *distinct* and *isolable added* to what is going on in a living tissue," but is a perversion primarily of quantity, and beeause of this excess oceasioning an incompleteness of textural changes as relates both to *decay* and *renovation* in the part, the profuse waste

and degeneration being united to "excessive textural productivity" to make the diagram of inflammation; and if the *normal or healthy waste* is the result of *oxidation* of tissue already existing in the part, and the normal or healthy production of tissue is the result of *deoxidation* of material brought to the part, the healthy waste and production passing regularly and co-ordinately through successive stages of their respective chemical processes, and the unhealthy ones being essentially characterized in their results by conditions to be produced by disturbances in these chemical processes, may we not fairly look to the chemical disturbances for the source of the pain of inflammation?

If we accept chemical action as the source of the *objective* symptom *increased* heat, having the most direct proof of the relationship of the temperature in a part and the oxidation going on there, as effect and cause, why should we not presume the same relationship for the *subjective* symptom pain, and the oxidation, since the pain characteristic of inflammation is so intimately associated with that of increased temperature? The want of co-ordination of the pain with the temperature where destruction, sloughing in large mass, has occurred, has nothing to do with the question now before us, no more than the absence of pain in inflammation of a part where there is paralysis of the sentient nerves, or of the sensorium itself, or the patient is narcotized; and in all other well-defined differences, as to the pains of inflammations, we have proof of difference in the chemistry of the part.

We have differences in the chemical components of the various tissues, and even of the blood of different vessels (Lehmann), which serve to explain, on strictly chemical grounds, the greater or less activity of the wear, and tear, and repair of those parts, and also such differences in parts and in individuals as might likewise account for their differences in acuteness of perception.

Every one will readily admit some such differences as chemical ones for the pain of gout and of rheumatism; and where is the improbability, then, of its being the source of the pain belonging to inflammation? And if admitted for differences

in individuals, why not for differences in locality besides the yielding of tissue in the same person, for we have seen such chemical differences for the contents of the vessels? The differences in suffering of patients, so clearly associated with the weather, the seasons, and the time of day, must surely be dependent on some such differences as those for which we are arguing.

A man in the healthy wear and tear of tissues, converts by chemical action that so used into effete matter, and removes it from its original locality with such precision as to prevent all "*appreciability*" of the various stages of the process; but not so where there is inflammation; there irregularities show themselves, other combinations of the elements are to be found, excess of normal products, new ingredients, the results of "imperfect elaboration," all indicating a striving for *more rapid change* than the parts can complete. One of the earliest steps of this process—the conversion of the carbo-hydrates into their ultimate products of retrograde metamorphosis in health—is the formation of "*lactic acid*," an important constituent of the juice of flesh. (Odling.) At what stage in the process, and in what quantity it is formed, very probably varies with the special tissues, for some tissues are in themselves more highly elaborated, or more promptly oxidized than others. Such an acid, then, in *abnormal* quantity, or at an abnormal point, would serve to explain many conditions of inflammation, and likewise account for its pain. The differences in various inflammations, and various stages of them, indicated clearly by *the* pains with which they are accompanied, can then certainly be dependent on the activity of the oxidation, just as we have seen the differences in decay and putrefaction, the process of destruction being in fact one of degree only, in this respect, between the healthy, the diseased, the dying, and the dead. As was pointed out by Gerhardt more than twenty years ago, the chemist can, by treating the superior substances with *oxidizing* agents, gradually descend the scale of complexity, converting these substances into more and more simple products, by successively *burning off* a portion of their carbon and hydrogen. Indeed, Strecker has in this way shown that the lactic acid, as one of the proximate results

of the destructive metamorphoses of flesh, may be followed through various stages. Thus:

Lactic Acid, ...	$C_6H_5O_5HO$.
Less, ...	$C_2H_2O_2$.
Acetic Acid, ...	$C_4H_3O_3HO$.
Less, ...	C_2H_2.
Formic Acid, ...	$C_2H_1O_3HO$.
Less, ...	H_1.
Oxalic Acid, ...	C_2O_3HO.
Less, ... :	C
Carbonic Acid, . .	CO_3HO.

And although we cannot assign each one of these products specially to a stage or form of inflamed or dying tissue, we have presumptive evidence of their belonging to such, not only because different acid products have been found in, and proved to characterize decay and putrefaction, but one series of such relations has been shown by Bouchardat and Sandras for formic acid, and the state of inflammation in which we have extreme obstruction in the circulation, as that of carbuncle. This acid—formic acid—is "a substance enjoying a very extensive natural distribution. In the vegetable kingdom it occurs in the juice of the stinging nettle, in decaying pine needles, and as a product of the spontaneous oxidation of turpentine, &c. In the animal kingdom it has been occasionally recognized in human blood, urine, perspiration, and in the fluids of the spleen and *muscles*. It also exists in the juice of red ants, from which it may be obtained by simple distillation —in the corrosive fluid of certain eaterpillars." (Odling.) This acid is at least isomerie with that of the bee-sting, and those of many if not all animal poisons (Day), the difference between them being probably only one of eoncentration. And who has not had his own experienee, not only of the acuteness of the pain from the bee-sting, but also of the immediate relief which earth affords when directly applied to the part injured by it? Day says that, in cases where the normal oxidation of the blood is impeded, it may collect abnormally in that fluid in sufficient quantity to be deteeted ehemically. Sherer has

separated it from the exudations in pyæmia, and has found it both free and combined, often in very considerable quantity, in the exudations of puerperal fever.

There are other acids, of a volatile character, "often found in increased quantity whenever the normal oxidation is impeded," (Lehmann), which may in this way have to do with the pains of inflammation.

We can in like manner, even from the imperfect data that we now possess, indicate a chemical rationale of what occurs in the effusions of inflammation which give rise to its swelling and other products, wherein we can readily perceive the earth's modus operandi as a remedy.

At the very outset of an attack of inflammation, or where the disturbing cause has been a trivial one, we have simply increased activity, characterized chemically by increased alkalinity of the intercellular fluids of the part. This besides increasing the quantity of blood in the part, increases the tendency of the oxygen to combine with certain elements ("the carbohydrates"). From this we have an increased quantity of lactic acid there, and the last-named substance not only drains the vessels of their liquid plasma, but acts with excessive energy on it after it is effused, rendering it abnormally turbid. This turbidity having not only been shown to be the result of separated albumen, but to disappear with the addition of a neutral salt, is evidently the product of chemical action, and a product too, which we have seen the earth was capable of removing, for we have seen the earth render neutral a surface which, prior to its contact, was markedly acid or alkaline. Besides keeping down all excess of turbidity, we have seen the earth was capable of *removing* the excess of effusion through its power to *devour* the liquid portion itself, decomposing even pure water to satisfy its greed for oxygen.*

Having discussed with sufficient detail for our purpose the process and the phenomena of inflammation, we can now pass to the healing processes, as in the consideration of them we shall have to discuss with some minuteness the characters and

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* Hence the rapidity with which wet clay will dry.

essentials of the products of inflammation which have not as yet been considered.

In entering on this subject, the *possibility* of the immediate union of an open incised wound, the occurrence of which is frequently denied, must be accepted, for where the severed parts are *directly* brought together, and well protected from disturbing influences, "no new material is formed to connect them, but being placed in contact and so maintained, they first merely stick together and then become continuous." (Sir James Paget, Holmes's Surgery, vol. i, p. 582.) The same high authority says: "The best examples of this mode of healing may be seen when flaps of skin have been raised by simple dissection, and then replaced on the subjacent parts; as for instance, in the removal of a tumor, as of a mammary gland, within three days; or in small wounds, within one day, the union may be complete, and little or no trace may appear of the line or plane at which the parts were separated. The process is so simple that it is best described by negatives. No sign of inflammation is observed; no evident afflux of blood; no exudation of reparative material; no scar; and no other conditions are required for the process than coaptation of the wounded surfaces, and the absence of inflammation at them." (Ibid., p. 583.)

Here then it would seem there is no disturbance in the nutrition of the part as it goes on in health. But such is not the action which commonly has place in wounds of any magnitude. As a rule it may be fairly stated, that the divided parts in even a clean incised wound, when at all extensive, are not usually brought into perfect coaptation, and there is considerable interruption to the circulation, or some inflammation quickly sets in, and, as a consequence, an effusion of "plastic lymph" takes place. "In either case the connection is finally re-established by the organization of the lymph, into which vessels pass from both surfaces; but the intervention of this bond is manifested in the persistence of the cicatrix, which is quite distinguishable by its peculiar appearance from the surrounding tissue." (Carpenter.) "The lymph in this method of union (*healing by primary adhesion or adhesive union*), being placed on both the cut surfaces, and probably exuding or growing alike from both,

combines them. Very little, if any, is infiltrated beneath the surfaces. Appearing to the naked eye as a ruddy or a pinkish-white soft and adhesive substance, it shows with the microscope cells like those of granulations in their several stages of development." (Paget, op. cit., p. 584.)

"The first portions of this process, extending to the time at which the lymph becomes vascular, may be accomplished within forty-eight hours. In the case of small wounds the process begins almost immediately after their infliction; in that of large wounds a period of rest or inaction intervenes. The later parts of the process are comparatively slow, and at the distance of a week or more from the infliction of the wound, if anything tends to separate its edges, the lymph that unites them being still soft, though very vascular, and not unhealthy, will suffer gradual elongation and attenuation, till it may finally give way." (Paget, Ibid.) In this form of union there is no more than repair (of normal nutrition), in a limited sense, for in place of the division "some lowly organized tissue is formed, which fills up the breach and suffices for the maintenance of a less perfect life." (Paget, Lecture on Reproduction and Repair, Medical Gazette, 1849, p. 1022.)

In "any incised wound left open and kept moist," the union takes place by granulations. "Such a wound becomes coated, or as it were glazed over with a whitish film, containing abundant white blood-cells. If the surfaces of a wound thus glazed be brought together they will unite, the film probably becoming organized, and forming part of the bond of union. If they be left open the film increases so as to form a thin, grayish, or yellowish-white layer, which takes part in the formation of granulations."

But before granulations form, a period elapses varying from two to ten or more days, according to the extent of the wound and the tissues involved in it, in which no visible change occurs in the injured parts. Probably during this period of incubation, as it is called, the blood is stagnant in the vessels for some little distance from the wound, and the renewal of its streams, and their increase in size, by such an afflux as ensues in inflammation, constitute the first visible step in this healing process. The change in the supply of blood may be best seen

on the margin of cut skin, where it commences in from two to four days after the wound; or of a bone, where it commences on cancellous tissue in about a week; and in compact tissue in ten days or more.

"The first appearance of granulations, which may commonly be seen in less than a day after the appearance of increased vascularity, is that of a layer of soft adhesive white or pale pinkish substance on the surface of the wound. In another day or less this may become vascular, with bloodvessels growing into it from those of the subjacent parts, and then while it gradually increases to about a line in thickness, it acquires all the characters of granulations, a bright ruddy substance, soft, elastic, easily broken, succulent, and abundantly vascular, granulated on its free surface, and at its attached surface intimately united with the tissue on which it is placed.

"In minute structure, the new-formed granulations consist of cells, like those of inflammatory lymph, heaped together without apparent order, and connected by very little intermediate substance. Bloodvessels with walls of simple membrane extend into the cellular mass from the subjacent tissues. The largest vessels pass in lines directed nearly straight toward the free surface of the granulations, communicating on their way by many branches, and ending near the surface in loops or arches."

"The further stages of the healing process consist in the gradual development of the substance of the granulations into those of a scar, *i. e.*, into fibrocellular or connective tissue, and a superficial layer of epithelium. The former is developed progressively, from the deeper to the more superficial part of the layer of granulations; the latter from its borders to its centre. With the progress of this development, the layer of granulation becomes paler, drier, thinner, and less vascular; and as the epithelium forms on it, it becomes smoother, and changes its ruddy tint to a dim purple or pink.

"The completion of the healing, whether by adhesion or by granulations, is attained by the gradual improvement of the scar; the connective tissue becoming more and more like that of the original formation, both in its own elemental structures and in the paucity of bloodvessels, and the cuticle be-

coming thicker and more opaque. Both structures also acquire characters adapted to the particular positions that they occupy. Thus the scars of healed muscles and tendons are much tougher than those of healed skin; the latter also commonly acquire at length elastic fibres, and the cuticle of each scar becomes like that of the adjacent skin; and, even beyond this, improvement continues in the gradual loosening of a scar from its adhesions to surrounding parts. This is effected chiefly by the changes ensuing in the tissue of that part of the scar which is subcutaneous, and which gradually becomes looser, less tough, and more occupied with fat.

"During the whole period of the development of granulations and the perfecting of the scar, a process of contraction goes on which greatly accelerates the healing. Thus, if the healing of a stump be watched, the healthy skin may be seen drawn in and puckered before any cuticle is formed on the granulations, unless at their very margin; or, after the removal of any portion of the scrotum, the diminution of the granulating surface is evidently due more to its own contraction than to the formation of epithelium on it. By the same continued contraction new scars become gradually more depressed, and shorter, and draw more closely together the parts that they unite.

"Again, while granulations are forming, and till they are covered with cuticle, or 'skinned over,' pus is constantly being produced on their free surface. The earliest exudations flowing from open wounds are albuminous liquids, nearly clear, viscid, ready to dry into adhesive scabs, and containing comparatively few cells. The gradual transition to the characters of genuine pus, indicates a corresponding progress in the formation of granulations, and thenceforward their characters are mutually indicative. Healthy and developing granulations always produce and are indicated by normal pus, *i. e.*, by pus which is creamy, opaque, uniformly liquid, yellowish-white, and sufficiently abundant to cover completely the whole surface of the granulating wound. On the other hand, all defects and diseases of granulations are attended with morbid characters of pus.

"*Healing by secondary adhesion*, or, as it may be called, by

the third intention, is accomplished by the union of two granulating surfaces (*e. g.*, those of two flaps after amputation), placed and maintained in contact. In this state the two surfaces simply unite, or else new material, produced from either or both surfaces, adheres to both, is organized into continuity with both, and thus unites them. The two layers of granulations thus form one layer, which, however, having no free surface, produces no pus, and is gradually developed into connective tissue. The process is very similar to that of healing by primary adhesion, but in that the lymph on the cut surfaces is not developed into granulations before the union. All granulations, however, will not thus unite; they must be healthy, not like those of sinuses, not profusely suppurating, not exuberant or œdematous."

"*Healing by scabbing*, or under a scab, is the most natural, and, in some cases, *the best* (the italicizing is ours) of all the healing processes. Very commonly in animals, if a wound be left wide open, the blood and other exudations from it dry on its surface, and entangling dust and other foreign bodies form an air-tight and adherent covering, under which scarring takes place, and which is cast off when the healing is complete. The exact nature of the process has not been watched, but it seems to consist in little more than the formation of cuticle on the wounded surface, and it has the advantage, that as no granulations are produced, there is little or no contraction of the scar. In man, the same process is less frequent; it is more apt to be spoiled by inflammation, producing exudations under the scab, which either detach it, or prevent the healing of the surface beneath it. Sometimes, however, the blood shed from a wound coagulates and dries on it, and remaining as a scab permits healing under it; or, if this do not happen, a similarly effective scab may be formed by the serous fluid or lymph by which the surface of an exposed wound usually becomes glazed; or, more rarely, the pus of a granulating wound may scab over, and sound healing take place beneath."

"*Nature of the healing processes.* After every wound there is some tendency to an inflammatory process; and this is the greater, in general, the larger the wound, the longer its exposure to the air, and the greater the violence with which its

infliction is accomplished or followed. This tendency to inflammation may not proceed beyond an increased sensibility of the part, and an increased supply of blood. There may be no inflammatory exudations or formation, and when this is absent there may be the best healing. Or, when the inflammatory process goes on to the production of lymph, then it may cease, and the sooner it does so the better for the healing."

"Thus, in healing by immediate union, inflammation is a hindrance if it proceed to exudation, for no new material is required; the divided parts should simply and directly reunite; and if any inflammatory product be formed between or near them, it either retards, or at the best does not assist their union.

"In healing by adhesion, an inflammatory process with exudation ensues, and may generally be regarded as necessary for the production of the new reparative material. But it should not go beyond this; its continuance is a hindrance to that organization of the lymph which is essential to complete adhesion.

"So in healing by granulation. If inflammation be present (and the lowest grade of it is best), it is only for the production of the first material for granulations. Their organization and continued healthy formation are retarded, or completely prevented, by any persistent inflammation."

"For healing by secondary adhesion, and for that with scabbing, the absence of inflammation is essential." (James Paget, Holmes's Surgery, vol. i, pp. 584–8.)

A great obstacle to the healing process is evidently then the presence of inflammatory action in the part, for although we may seek or need the aid of such action to place the part in the proper state, when that state is once brought about, such action must be gotten rid of before the desired process can be set up. Thus we have in lacerated wounds, in burns and sloughing ulcers, tissues there which are either too much damaged to recover, or entirely devoid of vitality, and must be removed before the healing can commence; but the process by which nature removes them, is most positively adverse to that of healing. The part for which we invoke inflammation in such cases—*its destructive action*—must clearly be made to

cease, before we can hope for healing to begin, and even in the only instance where it can be claimed that we literally seek inflammation, where there is no preliminary removal of effete matters to be accomplished, that is, very exceptionable cases where there is want of action, it is not the destructive action of inflammation that we seek; on the contrary, we even then wish to escape it, and it is our inability to separate the formative action from the destructive, that makes us always fearful of, and often to regret the consequences of inflammation, when once provoked in a part where the action was previously of an asthenic character. We do not in fact want *inflammation*, but increased formative action—and not even that which belongs to inflammation—for with the increase which it brings, there is always a characteristic *incompleteness* of the formative action. In inflammation, and even in the simplest interruption in the circulation of the blood, by a wound, the blood-bioplasts (white blood-corpuscles) multiply, and the capillaries often appear to be filled with them. "The vessels and their contents then very closely resemble those of an animal during the early period of its development. This state of things always exists in inflammation, and the multiplication of the bioplasts often proceeds to a wonderful extent." The appearances seen are certainly not due simply to the *accumulation* of white blood-corpuscles, as some have held, but only in part to this, and mainly to their actual growth and increase. (Beale.)

The liquor sanguinis is also transuded more abundantly and more completely (that is, carries with it more constituents, including oxygen deozonized) in an instance of interruption to the circulation, than when the blood flows freely through the vessels. This serum so extruded holds in suspension a greater number of very minute "bioplasts probably detached from the larger ones growing and multiplying in the vessels, and these particles, which may be the offspring of the germs of various structures, multiply, but owing to the character of the pabulum which serves for the purpose, they do so in an abnormal way." Thus we can understand why the cacoplastic lymph has leucocysts more numerous and with better defined outlines, than the other forms of lymph (Lehmann), and the further the deviation the more marked is this *excess* but *incompleteness* of formative

action, "until we have these germs all resulting in a peculiar product, for white blood-corpuscles, minute masses of germinal matter, lymph-corpuscles, germinal matter of nerve, muscle, and other tissues of the body, may give rise to *pus*, if placed under conditions in which they are too freely supplied with pabulum." (Beale, p. 43.)

This *product* of inflammation, although having germs possessed of remarkable vital properties, is essentially characterized by those two features, *excess* and *incompleteness*, which are peculiar to the work done in inflammation. Feeding on the pabulum the germs reproduce themselves at a most wonderful rate, but they cannot proceed further—"they cannot form tissue, nor produce tissue-forming bioplasts of any kind whatever" (Beale); for "the pus-cell then is no fruitful result. Essentially final as regards all manifestations of life, it now can only decay. Where it is the product of an exterior part, of an open sore, of a mucous membrane, of an abscess, we recognize its deciduous character. It is shed as though it were a slough. Where this is not the case, the cell slowly degenerates within the body by processes which have already been described." (Holmes's Surg., J. Simon.)

"The pus-corpuscles usually figured and described, are *dead*, not *living*. These spherical granular corpuscles have no longer the power of growth or multiplication. In many coagulation has taken place on the surface, and thus a sort of 'cell-wall' has been formed. Within this are granules and minute oil-globules, resulting from the disintegration of the living matter of which the corpuscle originally consisted, and germs of bacteria. Such pus-corpuscles do not alter their form of their own accord. After a time they undergo further disintegration." Thus we have *excess* and *incompleteness* in the decay also manifested.

"After standing for some time, the pus-corpuscles begin gradually to sink; the pus is then, however, generally changed in character, and the cytoid corpuscles exhibit more distinctly the nuclei which had previously been scarcely discernible. The serum of the pus has a less decided alkaline reaction than that of the blood; indeed, sometimes, it is acid, and when placed

in a vacuum this kind of pus commonly evolves sulphuretted hydrogen." (Lehmann, vol. iii, p. 147.)

"The mere size of the linear diameter of a cytoid corpuscle frequently furnishes a clue to the nature of the fluid from which it was obtained; thus, for instance, Henle found that the cytoid corpuscle in the pus measured, on an average, from 0.004 to 0.005′′, that those of the saliva and mucus were somewhat larger, and those in the blood were on an average smaller. These differences he ascribes, undoubtedly with much truth, to the different densities of those fluids. When, therefore, we find that the mere density of the blood, on which depends that of almost all the other juices of the animal body, exerts so great an influence, we can scarcely suppose that the other qualities of the blood should exercise none whatever on the chemical constitution of the pus." (Ibid., p. 149.)

It would seem, according to Lehmann, to be clearly established, "that the investing membrane, the viscid contents, and the nuclei, are substances very closely allied to albumen, nearly all of them exhibiting the reactions peculiar to the protein bodies." (Vol. iii, p. 153.)

The investing membrane is a protein body, which does not merely swell in a gelatinous manner in very dilute acids, but actually dissolves in these fluids. This property, which it exhibits in common with albumen and muscle-fibrin, distinguishes it very decidedly from blood-fibrin, which swells up, but does not dissolve in dilute hydrochloric acid. This membrane is wholly insoluble in alkaline salts, and does not dissolve readily, even in the caustic alkalies. These properties very strongly exhibit the points which mainly distinguish it from neutral albumen, which is poor in salts (such, for instance, as the albumen obtained from an alkaline solution by neutralization with acetic acid and by excessive dilution, or by the careful addition of dilute spirit), or from casein which has been freed from salt and acid (according to Bopp's mode of exhibition), whilst its behavior towards the caustic alkalies, and their carbonates, and borates, makes it approximate more nearly to muscle-fibrin (syntonin).

Normal pus generally contains from 14 to 16 per cent. of solid constituents. The purulent exudations which occur in

serous cavities and bad ichorous pus, often contain a smaller amount of solid constituents. These solid matters contain from 5 to 6 per cent. of mineral or inorganic substances in the pus of healthy persons, whilst the amount may rise to 10 or even 14 per cent. in bad pus, and in watery transudations. The ratio of the insoluble to the soluble salts in healthy pus varies from 1 : 7 to 1 : 9, whilst in bad pus it often equals 1 : 15 or even 23. It follows from these observations, that in bad pus a greater or smaller quantity of simple transudation must have become mixed with the true plasma of the pus.

"Acid pus is probably of very rare occurrence in the animal body; when pus has continued stagnant for a considerable time in the cavity of an abscess (in what are termed cold or congestive abscesses), it very generally undergoes alkaline fermentation; it then contains some carbonate of ammonia and triple phosphate, besides a large amount of sulphide of ammonium. I have only found the purulent exudations present in some few cases in empyema. Phthisical patients sometimes expectorate sputa having acid reaction, although no acid substance had come in contact with the expectorated matters, either whilst they were passing through the mouth or after they were thrown up. The rare occurrence of acid pus is the more remarkable, as it very rapidly turns sour on being left in imperfectly closed vessels. When healthy pus is suffered to remain for several days in a corked bottle containing a certain amount of air, and exposed to a summer temperature, we find on examining it under the microscope, that the corpuscles have swelled and become more transparent, whilst the fissured nuclei are also speedily brought more distinctly into view; after a longer time the reaction is decidedly acid; numerous isolated nuclei without a trace of cell-walls, and some few perfect corpuscles, are seen under the microscope, and interspersed amongst the corpuscles and the nuclei are innumerable molecular granules, whilst here and there we may detect tablets of cholesterin and a confused mass of threads of margarin." (Lehmann, op. cit., vol. iii, p. 159.)

In the instance of the fresh exudation of wounds free from blood, that of wounds inflicted upon eight rabbits, taken as soon as it began to flow free of blood-corpuscles, Prof. Lehmann states: "100 parts of the solid residue contained (as

was determined by direct incineration), 12.341 of mineral substances (the solid residue of the serum and of the fibrin yielding 9.971 per cent.); 100 parts of the salts of the secretion from the wounds yielded 41.145 parts of chlorine, 5.819 of phosphoric acid, and 6.941 of potash; whilst from that of the liquor sanguinis there were obtained 53.145 per cent. of chlorine, 2.014 per cent. of phosphoric acid, and 4.814 per cent. of potash."

"In the solid residue of the secretion from the wounds in three geese there were 15.148 per cent. of mineral substances (in that of the liquor sanguinis there were 11.155 per cent.); 100 parts of the salts of the wound secretion contained 7.018 per cent. of phosphoric acid, and 7.147 of potash; whilst in those of the corresponding liquor sanguinis there were 3.118 of phosphoric acid, and 4.663 of potash." (Lehmann, vol. iii, p. 150.)

In both these instances of lymph from recent wounds there was not only a positive increase of (both) phosphoric acid and potash over what there was in the liquor sanguinis, but the increase of the phosphorie acid was greater than that of the potash, and these facts are of considerable importance, for "it was first shown by Liebig in his investigations of the muscular juice, and has been subsequently confirmed by C. Schmidt, Lehmann, and others, that those fluids which are very rich in phosphates, and whieh exhibit an acid reaetion, contain only a small amount of soda salts, but are very rich in potash compounds; and Graham's experiments show that there is a considerable difference in the diffusibility of potash and soda salts." (Day.) Soda has also been shown to be the means of keeping the albumen fluid in the liquor sanguinis and other fluids, indeed, "the albumen of the blood serum is combined with soda in two different proportions, one of these albuminates being rich, and the other poor in soda; these two albuminates of soda (one of which is neutral, and the other a basic compound), are mixed together in the blood in variable proportions, and it is only in disease that free albumen is found in this fluid." (Day.) The marked diminution in the chlorine, as noted in the lymph from the wounds in the rabbits, confirms the absence of the soda. We have presumptive evidence from these facts that increased formative action will go on in

a recent wound, as the presence of acid phosphates and potash salts has been supposed to increase such action, and the inference is a fair one that they serve such a purpose from the facts, "that where cells and fibres are formed phosphates are accumulated in appreciable quantity; and it has likewise been ascertained that the blood returning from organs remarkable for the activity of their metamorphosis, contain far less phosphates than the corresponding blood returning from organs which exhibit a less amount of vital activity; moreover, the diminution of such ingredients in cacoplastic material, and the ratio of such to be found being inversely to the amount of oxidation which has had place, sustain such a view."

"We can now understand how the bioplasts (leucocytes, &c.), of the blood increase in number when the fluid in which they are suspended moves slowly, as at an early period of life before the propelling apparatus is fully developed, or at any period of life when the circulation is retarded from any cause whatever" (Beale, Diseased Germs, p. 23), and how they consequently set up increased action in the tissues. If, however, "the circulation soon returned to its normal rate, the increased number of white corpuscles in the capillaries would soon pass into the circulation and become lost in the mass of the blood, where they would undergo further changes. There would be no stronger evidence of even a temporary disturbance of the healthy condition than was afforded perhaps by some trivial nervous derangement, possibly giving rise in the case of man and the higher animals to slight pain, which might soon pass off, or perhaps escape notice altogether." (Beale.)

The increased action then is essentially formative; we have an increase of phosphates (and they acid), in the part. But Lehmann has found that "the intercellular fluid of the tissues becomes from this increased activity more and more alkaline, and that *then* the subsequent crops of cells are less and less plastic, and this for the reason, that by the presence of alkalies the tendency to oxidation is extraordinarily strengthened." In fact both these results are in accord with what Baron Liebig has pointed out (in his Mutual Laws of Husbandry, p. 90), that "acids prevent, and alkalies promote, oxidation or decay in organic substances, which is the reverse of what occurs in

metallic substances, for with them the simple contact with acids powerfully promotes the oxidation, while contact with an alkali prevents it (iron coated with a dilute solution of carbonate of soda will not rust").

The acid state not only prevents, and the alkaline state promotes decay, but they would both seem to be intimately associated with all the actions which go on in their respective conditions of the part. Thus, the acid state we have already seen does more than simply prevent destruction, it serves as a deoxidizer of the reparative material, and is thus most positively and directly engaged in the formative action; and so with the increase of alkalinity, we have not only more oxidation, but more diffusion from it, causing and increasing swelling in the part, and with it not only heat and pain, but positive interference with the formative action there. Hence the *incompleteness* of the reparative action manifest as soon and as long as inflammation is present, in which we have seen excess of oxidation constituted the prominent part of the disturbance of the healthy action.

After increase of formative action, excited by the acid phosphates, &c., beyond certain limits, we must have, as we have seen, an excess of alkalinity brought about, and that too as a consequence of the former, but the latter when so increased may be more than sufficient to balance the former, for if not speedily neutralized by it, it may do even more than render the formative action incomplete,—it may go so far as to destroy, and that too fast, and then not only the formed, but the forming material suffers from it.

In the instance of blood in a wound, we have not only in the coagula a foreign body, but in the blood-corpuscles substances specially rich in phosphates and potash salts; hence they excite action, and if the coagula is a thin one, gluing the two surfaces together, the action may serve to organize it. If, on the contrary, the coagula is a thick one, and there is access of air to it, it may decay, and that too as rapidly as if it were removed from the body; the action which its phosphates can excite then is sufficient to produce warmth and moisture, which favor its destruction.

Hence our great difficulty in obtaining healing under a scab

or crust. Where such attempts have been made, and with the fairest prospects of success, the contact of the smallest amount of water, the detachment of the crust at any point, the movements of the part, so as merely to increase the amount of action in the slightest degree, will interrupt it by increasing oxidation, and any of these may, if continued and augmented, excite suppuration, and so for the time at least, put an end to the healing. Now it is everywhere recognized as a fact, that there is some virtue in the crust formed by the coagula of blood, or of lymph, or even of pus, and that this is something more than what is to be had from an impervious covering of inert material. Can the difference in amount of phosphates in the three articles used by nature, and which corresponds with the difference of the efficiency of the crust formed by the three, account for the latter difference?

With the recognition of the difference in the action of acidity and alkalinity over oxidation in organic and inorganic matters, we can here readily understand the different effects of metallic and vegetable or animal sutures and ligatures. They are all foreign bodies in the flesh, and as such must first excite action which is followed by excess of alkalinity. This alkalinity in the instance of the metals (particularly silver and lead) coats them, and prevents, as we have seen, their oxidizing, but with the animal or vegetable fibre, it hastens decay, and such action spreads from them to the parts in which they are. Hence organic ligatures or sutures cut out much sooner than those of metal. Iron does not do as well as other metals, but from its well-known power as an oxidizer, only confirms by its action this explanation for the behavior of the others. It does not, however, cut out as quickly as silk or cotton; the fluids can penetrate the latter; and so, if for no other reason, a greater amount of oxidation will go on where they are.

The newly formed and forming materials are not only susceptible, from being rich in oxidizable ingredients, of the destructive action which assumes the ascendency in inflammation, but by being rich in nitrogen are peculiarly capable of carrying on such action, when once excited to excess, even after the supplies of oxygen from the blood and atmosphere are cut off. The researches of Gmelin, Henri, Boussingault, &c.

make the reason for this quite evident, and thus we can account for the ammonia, sulphuretted hydrogen, &c., to be recognized in pus which has been pent up for a longer or shorter time in the tissues. The gentlemen just referred to, have shown that the oxidation goes on at the expense of various compounds of the chemical elements. Amongst them in forming tissue, nitrogen is abundant as an ingredient, and its greed for hydrogen is such as to decompose the water, and the oxygen so liberated carries on the destructive action. Pus under such circumstances becomes thicker and more creamy in its character. Microscopy shows that these changes are evidently the result of increased or continued oxidation, for besides the diminution of the watery portion of this product there are changes in the pus-corpuscles, easily to be noticed, and which are clearly from such action. "In many coagulation has taken place on the surface, and thus a sort of 'cell-wall' has been formed. Within this are granules and minute oil-globules, resulting from the disintegration of the living matter of which the corpuscles originally consisted, and germs of bacteria." (Beale, op. cit., p. 43.) In this condition the corpuscles are not capable of reproducing their like, and the only source of increase for them then is the inflamed tissues, hence we have a positive diminution in all the ingredients of this product. Especially if, as is usually the case under such circumstances, the inflammation has abated to a considerable extent. Where this abatement is complete, and "the pus remains in a cavity in the tissues, the fluid products may be absorbed, while a small quantity of cheesy matter, rich in oil and cholesterin, is all that represents what was once pus." (Ibid.)

Access of air and contact with water must have similar effect with pus, which we see is dying material, as we have seen follows them with dead animal matter, and this effect must be the sooner and the more evidently manifest, the nearer the pus had approached the latter state before it was subjected to those influences; they hasten its decay and putrefaction.

Virchow has pointed out a difference between blood and pus, which is important for us to remember here. He says, "Nearly every specimen of pus, although it may look thick when fresh, contains such a large amount of water, that it loses a great

deal more by evaporation than a corresponding quantity of blood. The latter only gives the impression of being more watery, because it contains a great deal of free (intercellular) but relatively little intracellular fluid, whilst in pus on the contrary, there is a greater quantity in the cells and less without them. When then reabsorption takes place, the greatest part of the intercellular fluid first disappears and the pus-corpuscles draw nearer to one another; soon, however, a part of the fluid from the cells themselves also vanishes, and in proportion as this is the case, they become smaller, more irregular, angular and uneven; they assume the most singular forms, lie closely pressed together, refract the light more strongly on account of their containing a greater quantity of solid matter, and present a more homogeneous appearance." (Lect. IX.) "This kind of inspissation," he observes, "is by no means so rare a process as it is often assumed to be, but on the contrary, of extremely frequent occurrence, and almost even more important than frequent;" and speaking of nature's efforts to remove pus by this process, he says, "In all these cases the reabsorption is at an end as soon as the fluid has disappeared. Herein consists the evil import of these processes. For the solid parts, which are not reabsorbed, either remain lying in the part as such, or they may afterwards soften, in which case, however, they do not usually undergo reabsorption, but for the most part give rise to ulceration. At all events, what is reabsorbed is not pus, but a simple fluid, composed in great part of water, a few salts, and a very small quantity of albuminous matter, and there can be no question but that we have here presented to us one of the most incomplete forms of reabsorption." This same eminent pathologist admits, however, of the possibility of a more favorable case of purulent reabsorption, "when the pus really disappears, and no essential part of it need remain behind." But here, too, the pus is not reabsorbed as pus, but first undergoes a fatty metamorphosis; every single cell sets fatty particles free within it, breaks up, and at last nothing further remains than fatty granules and intervening fluid. There then exists no longer either cells or pus; and their place is occupied by an emulsive mass, a kind of milk, composed of water, some albuminous matter and fat, and in which even sugar has

on various occasions been demonstrated; whereby a still greater analogy with real milk is brought about.

"It is the *pathological milk*, which afterwards comes to be reabsorbed; once more, therefore, not pus, but fat-water, and salts. These are the processes which may be denominated 'physiological reabsorption of pus,' a reabsorption in which pus is not reabsorbed as such, but either only its fluid constituents, or its solid ones after they have been considerably altered by an internal transformation."

The remarkable correspondence of this description of the changes wrought by nature in pus under the most favorable circumstances, to what is to be observed in pus, even of the worst character, which has been subjected to the action of earth, will impress any one, who may study the latter, as most singular. Indeed almost the first of effects observed by me in my clinical study of the earth-dressings, was this similitude of the changes in pus, and they became more evident the more minutely I studied the subject. So impressed was I by it that I was induced at a very early date (May 20th, 1869) to send a sample of earth which had been twenty-four hours in contact with a suppurating surface to Dr. Tyson, with the request that he would give, without any knowledge of what had been already observed, his impressions of the changes wrought in the pus. The following is his description of them:

"A lump of saturated earth was taken from a freely discharging stump, the surface which had been directly applied to the stump being covered with a thin layer of healthy, creamy pus. A little of this most superficial pus was examined microscopically, and found to contain normal pus-corpuscles. Next some pus was taken from the earth, just below the surface, and found to contain very few corpuscles distinguishable as such, but many shrivelled, irregular bodies, subsequently shown to be changed corpuscles. Still further below the surface, no corpuscles at all could be distinguished, in fact nothing remained which could be construed as being even an altered corpuscle. Showing that at least the morphological element of the pus had disappeared, although the earth at the corresponding situation, was still moist.

With a view of further determining the effect of the earth, a little was mixed with water, so as to form a sort of thin paste or mud. This was added, upon a glass slide, to pus presenting normal characters, and the effect closely watched under the microscope. At first the field was made up of corpuscles and the irregular, amorphous masses of dirt. In from a few seconds to several minutes, however, the corpuscles began to change their characters, by what appeared a shrivelling, so that very soon they had become so altered that they could not be recognized, and would not be known to be the remains of corpuscles, had they not been kept constantly in view. At this stage they corresponded to the irregular shrivelled bodies referred to as found in the examination of the earth taken from the discharging stump. A little later they disappeared altogether. These changes always took place more rapidly in the corpuscles nearest little masses of earth, but gradually extended to the more distant corpuscles, until all were affected. They took place also, independently of desiccations from evaporation, at the edges of the thin glass cover. That they were due to an effect of the earth is beyond question; but that they were the result of a chemical rather than a physical action of the earth, I am not prepared to decide. It is probable, that even though the earth was apparently wet throughout, there would still be interspaces filled with air; while, on the other hand, the action was too rapid to be accounted for by the mere desiccating action of this small quantity of air between the particles." J. T.

The reader, although possibly willing to admit, from the evidence which has been adduced, that earth can act as a preventive of decay and putrefaction, and of inflammation and suppuration, and even as an allayer of pain, and an absorber of effusions, and that it can do all these—not only by its chemical powers—but especially by its power as a deoxidizer, yet may fairly object to the recognition of any power in it to aid the repair of injured tissues; or at most, may be but willing, from what has been shown, to accord to it only a negative part in this respect, *i.e.*, by preventing inflammation; still it must be conceded that there were many cases, especially those of

old and indolent ulcers, where there was positive evidence of previous want of disposition to make repair, in which it ensued on the application of the earth-dressings. This last effect from the earth-dressings certainly implies a positive power exerted by them, and we have seen nothing in the process of nutrition, nor in the properties of clayey earth, as we have been studying them, to militate against such a possibility. Indeed, we have seen that the making of tissues is essentially one of deoxidation, and that such earth is a deoxidizer. Furthermore, with the recognition universally made of the active part taken by oxygen in *all* the processes of nutrition, and that the blood is the carrier of that element for those purposes, the analogy between the changes which oxygen undergoes in the blood—the states in which it is to be found there—and its changes and states in various earths, would make it quite plausible, that recently pulverized clayey earth could aid even the *formative* action, in a manner similar to that which healthy arterial blood does.

It will be remembered that "only from $\frac{1}{14}$ to $\frac{1}{11}$ of the oxygen which is absorbed by the blood can be absorbed mechanically; that is to say, by the water, or can consequently exist free in the blood—the large amount of remaining oxygen, $\frac{10}{11}$ at the lowest calculation, must be fixed by the blood-cells through the agency of some chemical attraction." (Day.) In clayey earth we have had the evidence of this power to absorb the free oxygen of the air, and to hold it by other than a mechanical means, most clearly demonstrated.

The blood has the power of taking oxygen, not only from the air, but even from water when in vapor; separating it from the other essential elements of those articles, the hydrogen and nitrogen, and expelling them. In the case of great humidity of the air, respired by a healthy individual, the two are expired together, and readily detected in combination as ammonia. (Weidkenhold and J. B. Read.) The nitrogen by itself, where the air breathed is a dry one; but in the instances of inanition, even the nitrogen itself is absorbed. (Regnault and Reisert, Ann. de Chem., 1849.)

The earth has been shown to be as ready an absorber of oxygen from the air and water, as the blood is, and to reject

the hydrogen and nitrogen, even in the form of ammonia, when they are in redundancy, as such can readily be detected in the air over a fertile field ploughed shortly after a rain. (Liebig.) Whereas a dry, impoverished field—one which has been exhausted of its nitrogen and hydrogen; or a sample of dry clayey earth, which is naturally devoid of those elements, will completely retain what is presented of them.

We have seen that the free oxygen, absorbed by the blood-corpuscles, afterwards (in the arterial system) presents in a marked manner, the modifications called *ozone*. The same is demonstrable in clayey earth which has been exposed to any source from which it can derive oxygen. We can even demonstrate it in both "by the property of decolorizing solutions of indigo, a property which ordinary oxygen is altogether destitute of." (Noad.) Thus by the administration of a solution of indigo, per orem, to a man, and its subsequent detection as isatin (white indigo) in his urine; and the same follows the filtering of such a solution through a clayey earth. Indeed, clayey earth and bullock's blood, have long been used alike on account of their decolorizing properties, to whiten sugars, and the property in this relation has always been located by chemists in the iron in both. Nay, more, it has been generally attributed to the relations of the oxygen with that metal, without always the recognition being made of its influence over the production of the ozonized state in them.

Not only have we the evidence of the production of ozone in both animal and vegetable life, but also the indications that the active chemical changes which occur during growth in both, are intimately connected with that state of oxygen. Furthermore we have all the circumstances which are known to modify the production of ozone in nature, alike effective in animal and vegetable growth. Then as the process of production of tissue has not only been supposed from various considerations to be one of *deoxidation*, but has been actually proved to be such, and as the power of ozone to act as a deoxidizer is equally well established, the conclusion may be fairly drawn, that it is the oxygen in its ozonized state which is the active means of producing those chemical changes which result in the formation of tissue.

It would then seem that we can not only get rid by the action of the earth of the destructive action belonging to inflammation, but may effect through it a more complete formative action.

The power in clayey earth to produce ozone, and the means and the manner by which its production is accomplished there, are so analogous to those for the same product in arterial blood, that the assumption that clayey earth aids the process of repair when used as a topical application, is no more unreasonable than that it is efficient in preventing and delaying decay and putrefaction by its power to absorb and render inert for the time the free oxygen, which we have every reason, from analogy and well-established facts, to believe is the active state of that element in those processes.

The effects of the clayey earth in producing coagulable lymph in the vesications from burns and scalds, so constantly noticed, and which have been commented on prior to this, would certainly, when placed alongside of Besanez's results of the action of ozone on the production of fibrin, seem also to confirm this claim for the earth-dressings.

Admitting such to be one at least of the clayey earth's modes of positive action in the healing processes, we can have no difficulty in explaining the fact, that it is efficient in that respect only when in a dry state, and why it should cease also to allay pain when it becomes saturated by the discharges, or is prevented from becoming and remaining dry by an impervious covering like that of oil silk. So, also, we can comprehend some of the anomalies observed in the other effects of its use.

Ozone has been shown to be generated always most abundantly in nature when the conditions favorable to chemical action, light and moisture, are best defined. But in the instance of *wet* clayey earth, we have seen how ozone generated there can be absorbed, and so prevented from interfering as much with the action of the free oxygen as it can when the clay is dry; and when nitrogenized tissues are concerned such moisture hastens their oxidation. With sunlight we have not only the red rays, which are a powerful means (by their warmth) of increasing chemieal action, but also certain rays which possess

in themselves positively chemical powers, and of these, the rays of greatest refrangibility, that is, those at the blue end of the spectrum, have been shown to favor deoxidation.

Those rays can, therefore, be the means of aiding the power of ozone in the production of tissue. Such action of blue light has not only been studied from this chemical point by Prof. Draper (Chemistry of Plants), as regards cell-growth, but has been practically demonstrated at the gardens of Kew, in England, in relation to vegetation, and in this country, more recently, as regards both animal and vegetable growth, by Gen. A. J. Pleasanton, at his country-seat in the vicinity of Philadelphia. (See paper on the Influence of the Blue Color of the Sky in Developing Animal and Vegetable Life. Read before the Philadelphia Society for Promoting Agriculture, by Gen. A. J. Pleasanton, May 3d, 1871.)

Learning, in the early part of my investigations into the rationale of the earth-dressings of ozone, of the results which had thus been obtained by experiments with various portions of the spectrum, I was induced to test the influence of different colored coverings on the dressings, and soon had demonstrated, in the most positive ways, the advantage of the blue in intensifying or prolonging the action of the earth, and the reverse in the effect of the red coverings. These effects of the different colors have been made the subject of frequent demonstration and comment by me during my more recent courses of clinical instruction at the Pennsylvania Hospital, and I always on those occasions took the opportunity of referring to many of the common experiences of such effects in every-day life, and which appear to have been discovered by pure accident. I refer to the use of blue coverings or envelopes to preserve the colors and conditions of many delicate textures, and of red under-garments, popular as means of protecting one's self from colds and rheumatism.

Liebig has shown how the absence of light occasions the emission of carbonic acid gas from plants at night. "Plants," he observes, "during their life constantly possess the power of absorbing by their roots moisture, and along with it air and carbonic acid. Is it, therefore, surprising that the carbonic acid should be returned unchanged to the atmosphere along

with water, when light (the cause of the fixation of its carbon) is absent?"

"Plants which live in a soil containing humus exhale much more carbonic acid during the night than those which grow in dry situations; they also yield more in rainy than in dry weather."

We can thus see how the clayey earth acts more powerfully when in a dry state, and under the influence of blue light, than in the opposite conditions. And here we find a solution of the question previously raised as to the reason of the earth-dressings losing so evidently their power to allay the pain towards morning, especially when they have become saturated, as well as proving themselves less efficient as disinfectants under those circumstances.

All these results confirm the view that it is by the clayey earth's power to generate ozone and deoxidate that it favors formative action.

Nor should we in our estimate of the dry clayey earth's power in the healing processes overlook its influence on ammonia and the other nitrogen compounds, which we have seen are not only the products of the normal changes, but are in themselves prone to induce disintegration wherever they are, and this independent of any extraneous supply of free oxygen.

The presence of such products we have seen must be alike unfavorable in decay, putrefaction, inflammation, suppuration, and in any form of the healing processes; and the peculiar power, as demonstrated by Prof. Way's researches, in all the double silicates of alumina (which are the essential constituents of clayey earths), to absorb and fix such products, is one entirely independent of their power as deoxidizers or absorbers of oxygen, and gives them a property especially in the healing processes of fully as great value as either of those.

For it is not in a negative manner only that the earth acts here beneficially. It will be remembered that Prof. Way (op. cit., p. 133), lays great stress on the fact that this power to fix ammonia is the result of a peculiar affinity. He has shown it was from "decompositions going on in such earths, between the various double silicates of alumina and ordinary salts of other bases, by which such silicates of soda, of potash, of lime,

and of ammonia, successively displace each other; thus, the soda silicate is decomposed by salts of either potash, lime, or ammonia; the potash silicate again is decomposed in its turn by lime or ammonia; and lastly the lime compound by ammonia; and as the reverse of this action cannot occur, the double silicate of alumina and ammonia cannot be decomposed by any neutral salt of the other alkalies." (See op. cit., p. 516.)

The double silicate of alumina and potash, which we know is abundant in the clayey earths which I have been using, must therefore have its potash displaced by the free ammonia generated in all retrograde metamorphosis.

Hence when such earth is put in contact with a wound or granulating surface, the ammonia from the effete nitrogenized tissue, pus or exudation, will be absorbed, and the potash base of the silicate will be set free. The presence of the potassa so liberated must, according to the views of Schmidt, Lehmann, and others, increase or tend to make more perfect the formative action in the part. Hence we may claim for earths possessing such silicates a positive power to aid formative action in the flesh when brought in close contact with it.

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